DIETOTHERAPY

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NUTRITION AND DIET IN HEALTH

BY

WILLIAM EDWARD FITCH, M.D.

MAJOR MED. RES. CORPS, U. S. A.

FORMERLY LECTURER ON SURGERY, FORDHAM UNIVERSITY SCHOOL OF MEDICINE; ASSISTANT ATTENDING GYNECOLOGIST PRESBYTERIAN DISPENSARY; ATTENDING PHYSICIAN TO THE VANDERBILT CLINIC, COLLEGE PHYS. & SURGS., NEW YORK CITY

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FORTY CONTRIBUTORS

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CONTRIBUTORS TO VOLUME II

A. L. BENEDICT, A.M., M.D., F.A.C.P.
Capt. Med. Res. Corps, U. S. A.; Consulting Gastro-Enterologist, Buffalo Hospital, Buffalo, N. Y.

WILLIAM E. FITCH, M.D.
Major Med. Res. Corps, U.S.A.; Editor Pediatrics, New York City

---

H. S. GRINDLEY, B.S., Sc.D.
Professor of Animal Nutrition, College of Agriculture, University of Illinois, Urbana, Ill.

WINFIELD S. HALL, B.S., M.S., M.D., Ph.D.
Professor of Physiology, Northwestern University Medical School; Lecturer on Dietetics, Mercy and Wesley Hospitals, Chicago

---

H. LYONS HUNT, M.D., L.R.C.P. (Edin.)
Capt. Med. Res. Corps, U.S.A.; Prof. of Medicine
University Medical School, New York City

GEORGE N. KREIDER, A.M., M.D., F.A.C.S.
Captain Med. Res. Corps, U. S. Army

H. EDWIN LEWIS, M.D.
New York City

A. BRUCE MACALLUM, A.B., M.D.
Lecturer Biological Chemistry; Sen. Fel. in Medical Research, University of Toronto, Toronto, Ont.

E. E. SMITH, Ph.D., M.D.
Formerly Professor of Physiology and Biological Chemistry, Fordham University School of Medicine, New York City

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VOLUME II

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CHAPTER I

FOOD PRESERVATION

H. S. Grindley, B.S., Sc.D.

Methods of Food Preservation: Drying; Smoking; Salting; Freezing; Refrigeration; Sterilization; Exclusion of Air—Canning; Treatment with Antiseptic Agents.

METHODS OF FOOD PRESERVATION

The different methods of food preservation have of late years received much attention, for it is very largely due to the different processes of preserving food that it is possible to maintain large armies and navies in action and to permit of the aggregation of men in communities away from all immediate sources of food supply. It was originally thought that mere contact with the air was the prime cause of the decomposition of food, but experiments have proven that the great number of germs contained in even comparatively pure atmospheres are the real agents of putrefaction, rather than the air itself. The basis of all food preservation depends upon the principle of preventing microörganisms present in the atmosphere from coming into contact with food to contaminate it. Since germs of putrefaction require a certain amount of moisture and heat for their growth, such foods as contain little water, and that are not kept too warm, are not so likely to undergo decomposition; on the other hand, foods containing much water undergo fermentation very rapidly.

Yeo(1) has suggested the following classification of the methods for preserving food products:

(*a*) Drying	(*e*) Refrigeration
(*b*) Smoking	(*f*) Sterilization
(*c*) Salting	(*g*) Exclusion of air—canning
(*d*) Freezing	(*h*) Treatment with antiseptic chemical agents

Drying.—Drying is the primitive method of preserving food. Of course, in this process a large proportion of water is extracted. Pemmican (*see* page 19) is a form of meat preserved by this method. At present this form of preserving food is limited mainly to fruits and vegetables, although, in some sections of the great West where excessively dry and clear atmospheres are found, meat may be hung in the open anywhere and be preserved by this method. *Biltong,* or dried beef, sometimes called "jerked beef," is kept by cutting it into thin slices and drying it in the sun for several days. Familiar instances of preservation of fruits by this method are found in raisins, figs, dates, prunes, dried apples and peaches, used also for some vegetables such as lima beans, okra, corn, etc. Desiccated meats and vegetables, used largely for making soups, have the advantage of being easily transported and at the same time of producing nutritious food. (*See* Volume II, Chapter II, Dehydration.)

Smoking.—Smoking is the preservation of meat or fish by means of volatilized creosote and other substances developed from wood smoke, which have an antiseptic action. This process of preserving meat is principally applied to beef, tongue, ham and bacon. The meat, on being slaughtered, is first put down in salt for several days; it is then taken up and hung in a chamber or confined "smokehouse," and a saturated wood fire is started. This fire is usually made of green wood and scraps of leather thrown on the top to add to the smoke.

The creosote rising from the wood during combustion closes the pores of the meat to some extent, thereby excluding air-containing bacteria. Juniper berries and fragrant woods are sometimes put into the fire to give additional flavor. In North Carolina and Virginia, the famous "Smithfield hams" and bacons are cured by being smoked as above for a time and then taken down and the fleshy part of the meat rubbed over with sugar, pepper and other condiments. Then saltpeter, which acts as an antiseptic, is rubbed well into the flesh, and the meat is laid on a bench for a few days and afterwards hung and smoked again. Later it is washed and dried, and again exposed to the fumes of the "smokehouse." The outer

surface of meat, such as ham or bacon, preserved by smoking, becomes considerably drier and tougher than the interior, but the latter is not made especially tough by the smoking if it was originally tender. Well-smoked bacon sliced thin and thoroughly cooked is a very digestible form of fatty food. The digestibility of hams is also enhanced by the smoking process. In some instances the process of smoking is applied largely to the preservation of fish, and their digestibility and flavor are not impaired by smoking.

Salting.—The salting of food as an agency of preservation is a method that has been practiced for many centuries. In this way, meat and fish are easily preserved. Salted meat usually becomes pale from the action of the salt upon the hemoglobin contained in the blood vessels of the muscle fiber. The addition of a little salpeter prevents the meat from becoming pale by preserving the original reddish color of salted meat.

Freezing.—Freezing is a method of preserving food which necessitates immediate cooking after thawing, to prevent decomposition. Excepting milk and cream, foods are not easily eaten in an actual frozen state, except by the northern Eskimos, who prefer their meat in that form. Meat and fish may be kept for considerable periods of time frozen in blocks of ice without losing much in flavor, but vegetables are not as good when cooked after being frozen. Meat which has been frozen is much better cooked by roasting than boiling, unless it has been imperfectly thawed, in which case the central portion may remain frozen after the external layers have begun to cook, and when very large cuts are cooked by roasting, the inside, on being cut into, may be found almost raw. Frozen meat loses about 10 per cent of its nutritive value in cooking.

Refrigeration.—The preservation of meat by refrigeration or cold storage has in the past few years practically revolutionized the meat trade. This method of preserving meat has enabled cargoes to be brought from distant countries through equatorial regions not much the worse for the voyage. Slaughtering and refrigeration go on all the year round at the great slaughtering houses in this country, and the tables of both rich and poor in the large cities are constantly supplied with beef, mutton, lamb and chicken. From the earliest time the subjection of meat to extreme cold has been practiced in order to enhance its keeping qualities. Bacterial growth is inhibited to a greater or less extent by refrigeration, which consists (*a*) in actually freezing the meat, in which condition it may be kept without decomposition almost indefinitely until finally thawed for use, or (*b*) by keeping the meat at or near the temperature of freezing without

actually congealing it, as is done by the use of the ordinary methods of refrigeration. The second method, while much less efficacious than the first, serves to prevent much decomposition for a considerable time, and is preferred for beef, mutton and pork. Lower temperatures are employed with poultry and game. There are many processes of refrigeration in use: the direct expansion, indirect expansion by circulation of cooled air, etc.

THE EFFECT OF PROLONGED COLD STORAGE.— Dr. Carl von Baer reported to the Royal Society of London the discovery in Arctic Siberia of the body of a frozen mammoth, the meat of which was still preserved. As this animal had been extinct since the days of prehistoric man, it afforded an illustration of the marvelous preservative power of intense cold. In 1861 the entire bodies of three Swiss guides, who forty years before had been buried by an avalanche over the Glacier de Boissons, were found in a state of excellent preservation. With these examples of the influence of cold, it is little wonder that meat may be preserved for a few months on ice and yet be quite fit to eat.

These two instances, however, are hardly in harmony with the following experiences. Wiley(2) records his experience of examining a quarter of beef which had been kept frozen in a warehouse for more than eleven years. This meat was found to be wholly inedible. It had an unpleasant and a decidedly mummy-like odor, was light in fiber and color, having evidently lost a large part of its weight and was of a character wholly unsuitable for consumption. On one occasion, the author had an opportunity of inspecting a large quarter of beef which was furnished by a western packing house to the United States Army for food, and they claimed that it had been in cold storage for more than twelve months, and that it left the storage in a wholesome condition, having been inspected and passed by a representative of the Government. It was taken from the refrigerating cars still cold and delivered to the commissary department and was found to be putrid, with foul odors emanating from it. It was soft and of such a character as to be wholly unfit and unsuitable for consumption.

These facts appear to show that in the first instance eleven years is too long a time to keep meat frozen; in fact, it is scarcely worth while, from a practical point of view, to discuss so long a limit. In the other instance, the facts point out that a shorter period of time was conducive of no better results. Only the necessary time for the preparation and transportation of the meat is to be considered, and the sanitary laws of the nation, state and municipality should undoubtedly regulate the time of cold storage and see that all packages of meat exposed for sale are

plainly tagged as to the date of the slaughter, in order that the consumer may know what he is really purchasing.

A great variety of food materials are now kept for indefinite periods of time in cold storage—that is to say, they are stored in chambers cooled by air which passes over pipes conveying cold brine, carbonic anhydrid or ammonia gas. The circulation of such air, by keeping the substance at a temperature below that necessary for the development of putrefactive germs, is a sufficient protection against the processes of putrefaction. Experience has shown that the best temperature for the preservation of materials by cold storage is as follows:

REQUISITE COLD STORAGE TEMPERATURES FOR THE PRESERVATION OF CERTAIN ANIMAL FOODS

Brined meat	35 to 40° F.	Lard	34 to 35° F.
Fresh beef	37 to 39° F.	Fish	25 to 28° F.
Mutton	32 to 36° F.	Oysters	38 to 42° F.
Pork	30 to 33° F.	Poultry (frozen)	5 to 10° F.
Veal	32 to 36° F.	Poultry (cold storage)	28 to 30° F.
Ham	30 to 35° F.	Fresh fruit	33 to 40° F.
Vegetables	33 to 40° F.		

After all that has been said in favor of cold storage of meats, the fact remains that meat which has been in cold storage for any length of time is not as wholesome and tasty as absolutely fresh meat. It is the opinion of the author that much of the intestinal disturbance results from the end products of protein digestion, which are to some extent due to the ingestion of cold storage meats. The germs of putrefaction attack meat very soon after the animal heat leaves the carcass, and no matter how it is preserved or what methods are resorted to for its preservation, putrefaction to a greater or less degree goes on until the meat is cooked.

It is practically impossible to secure on the New York markets an absolutely fresh fowl, either duck, chicken or turkey; they have all been in cold storage for a greater or lesser period of time, and no matter what price is exacted for these fowls, when cooked, the flesh next to the bone will have an unsavory odor and a far from inviting or palatable taste. Even the "kosher" killed fowls, after a journey of several hundreds of miles without proper air, food and water, are sick, and such fowls are unfit for slaughter unless turned into an open lot and fed wholesome food for a few days. This of course is not done. The only people who enjoy absolutely fresh fowls and meat are people living in rural districts who can always secure fresh foods. Cold storage eggs are advertised and

sold as "eggs fresh from the farm," whereas they may have been in cold storage anywhere from a few months to a few years, and instead of having that fresh egg flavor, they will offer to the olfactory nerves an odor somewhat similar to that of a rancid oil.

Sterilization.—Sterilization, by the application of heat in sterilizing containers, renders meat or other foods germ free. Practically all thoroughly cooked food is, for the time being, "sterilized," and it is a well-known fact that overdone meat keeps longer than underdone meat, since the outer layers are firmly coagulated and dried by the heat of boiling or roasting which forms an almost impervious envelope, hermetically sealing it from the air. The products of decomposition in meat include albuminoses, leukomain, ptomain, hydrogen, carbon dioxid and marsh gas.

Exclusion of Air.—This is the preservation of food by a process of canning, the principles of which include the destruction of the organism which produces putrefactive changes, and afterwards, the hermetical sealing of the container to prevent the access of more bacteria. If the destruction of the microörganisms is not complete, the bacteria will still produce changes in the meat or vegetables, and the gases accumulate in the tin. If the pressure is great enough, the tin becomes "blown," the ends bulge, and the contents are unfit for food. The process of canning meat or vegetables is conducted somewhat as follows: The container is first of all boiled to kill any germs. The product to be canned should then be thoroughly sterilized by heat, and immediately placed in the container and hermetically sealed. Some unscrupulous manufacturers use antiseptics instead of heat, much to the detriment of the public health. H. W. Wiley(3), who made an exhaustive study of canned foods, says:

> All manner of food is canned, and that at prices which place it within the reach of the humblest pockets. Preserved food has been a great democratic factor, and has nearly obliterated one of the old lines of demarcation between the poor and the wealthy. Vegetables out of season are no longer a luxury of the rich. In the American grocery pineapples from Singapore, salmon from British Columbia, fruit from California, peas from France, okra from Louisiana, sweet corn from New York, string beans from Scotland, mutton from Australia, sardines from Italy, stand side by side on the shelves.

Of the dangers of poisoning from canned goods, Wiley says:

> Vegetables are usually canned in the fresh state, and if they are in any degree spoiled at the time the fact is usually conspicuously evident to the taste, so that the canner cannot afford to use them. Bacterial action seldom occurs in the can without bursting it or rendering it unsalable. Ptomains may, however, develop where the canned food is allowed to stand for some time after opening, though

even then this is unlikely in the case of preserved vegetables. It may be said, therefore, that the principal risks to health which may arise from the use of canned goods are those due to the use of preservatives, or to the presence of the heavy metals, copper, tin, lead and zinc. In this country there is no restriction whatever in regard to the character of the tin employed, and as a result of this, the tin of some of the cans has been found to contain as high as 12 per cent of lead. The analyses of numerous samples of solder employed show that it contains fully 50 per cent of lead. In addition to this there is no care taken to prevent the solder from coming into contact with the contents of the can. It is a rare thing to carefully examine the contents of a can without finding pellets of solder somewhere therein.

Treatment with Antiseptic Chemical Agents.—The use of various antiseptic and preservative fluids is designed to prevent activity of germs and fermentation. Sugar, like salt, in strong solution possesses decided antiseptic powers, and hence the employment of strong fluids for the preservation of fruits, and of sugar itself in making candied fruits. Other harmless preservative materials which are added are oils, chiefly serviceable for keeping fish, and vinegar and spirits of wine for pickling such products as chillies, tarragon and shallot. Vinegar is used to preserve oysters, lobsters and other sea food, as well as cucumbers, cauliflower and other vegetables. Fish are immersed in mixtures of cider vinegar flavored with cloves, nutmeg, parsley, bay-leaf, onions, etc. After being "soused" once or twice, the food is heated in the fluid to 140° F. Flavoring substances are added, and the whole is put into air-tight jars. The fumes of burning sulphur are sometimes used as a preservative of foods, especially fruits. Acetic acid, weak carbolic acid solutions and bisulphite of calcium are injected into the blood vessels of meat for the same purpose. Chlorid of aluminium, borax, salicylic acid and other materials have been extensively used for the preservation of milk.

Another method of preserving meat consists of injecting the animal, the moment it is killed, with a solution of borax, which is so uniformly distributed through the circulation to all the fibers of the meat, that only a very small quantity of the antiseptic need be employed. The preservation of meat by the antiseptic action of these substances, if used in excess, is apt to endanger the normal digestive functions, and besides render the meat less nutritious. The use of many of these chemical agents has been forbidden by federal enactment, and their use in all forms of animal food is everywhere condemned.

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CHAPTER II

PRESERVATION OF FOODS BY DEHYDRATION

H. Edwin Lewis, M.D.

Dehydration: Value; Methods.
Dehydration of Animal Foods: Milk, Casein; Eggs; Meat; Fish.
Dehydration of Fruits: Prunes; Apricots; Peaches; Plums; Apples; Unusual Fruits—Persimmons, Copra, etc.
Dehydration of Vegetables: Potatoes; Corn; Beans—Soy Bean, Lima Bean; Cabbage, Parsnips, Turnips, etc.; Use in Allied Armies.

Value of Process of Dehydration.—It will be quite in place, before going into details regarding the question of dehydration, to discuss briefly the whole subject from a broad outlook. First, stress should be laid on the fact that dehydration is the surest means known of preserving foodstuffs, especially those of the vegetable kingdom, for an indefinite length of time without injury to the products thus treated. Dehydration, indeed, is a most effective mode of really preserving vegetables and fruits, and to a lesser extent animal foods; the cellular membrane of vegetable matter is in no respect injured by the process of evaporation when properly carried out.

The vitamine element, now known to be so essential to the conservation of good health, is preserved in vegetables which are subjected to American evaporating methods. Moreover, the palatability and flavor of vegetables dehydrated in this manner are not impaired; in consequence, vegetables and fruits dried by this process retain to a really remarkable extent their normal flavor and fresh taste when prepared for the table. Furthermore, since their cellular tissue is uninjured, they resume their natural appearance soon after they have been soaked in water.

Proper dehydration is perhaps the most wonderful means of preserving food, particularly vegetable food, yet devised. This process does not harm the nutritive properties of the food. It represents the utmost food econ-

omy, and the translation of its principles into practice is peculiarly applicable to the present juncture, when war makes it incumbent upon all to avoid waste and to save the food supply by every known means.

Few persons have any idea of the fearful, almost criminal, waste of vegetables and fruits in this country. We are certainly a careless and improvident people. This is no doubt due largely to our living in a country of almost unlimited resources, where prosperity has always reigned and where stint or lack of food has been unknown.

The United States Department of Agriculture has stated that in the neighborhood of 50 per cent of the vegetables and fruits grown here never reach the consumer's table, and according to R. G. Skerrett(1), it is equally certain that the greater part of the product thus sacrificed does not leave the farm or orchard. This unfortunate happening is due to various causes—lack of transportation, the state of the market, but mainly because only the very best fruits and vegetables will pass final muster or will be in a condition which will ensure their sale at a profitable figure. All these difficulties might be overcome and could be overcome if facilities for proper dehydration were available.

It has been pointed out that scientifically dehydrated vegetables and fruits can be conserved for a practically unlimited period of time. It may also be stated that these same food products can be sold to the consumer at a price considerably below that of fresh products, which can only be obtained at certain periods of the year, and even below the price of canned foods of this nature. For instance, one pound of kidney beans dried artificially costs ten cents, a pint can of these same beans costs fifteen cents. One pound of the dried beans will go as far as four cans, in addition to providing a good deal more nutriment.

A weighty reason why Germany has been able to hold out so long in spite of the blockade may be attributed to a large extent to the fact that she had adopted, long before the war, a widespread system of preserving by dehydrating processes vegetables and fruits that otherwise would have been lost. Immediately before the war, there were more than four hundred dehydrating establishments in Germany, and since hostilities commenced, many more have been built. At the present time all the German cities of any size contain evaporating plants, by which means the surplus stock of farm products has been saved to tide the population over the lean days.

The public must be taught to realize the necessity for economy in food and should also be taught the value of dehydration as a factor in achieving this object. There is always a certain amount of prejudice against novel

ideas. Canning, at one time, was regarded with hostility, and cold storage was and is still looked upon with a good deal of distrust. Cold storage when not abused is a highly satisfactory method of preserving food, and canning possesses conspicuous merits. Perhaps the American people have contracted the "canning habit," or rather the habit of eating canned foods, with too great facility because canned food provided such an easy method of satisfying the food wants of the body. At any rate, a good deal of the prejudice which existed against canned foods has vanished. Now there is need for an educational propaganda to enlighten the public as to the nutritive and economic value of dehydrated foodstuffs.

DEHYDRATION OF VEGETABLES.—Dehydration as applied to vegetables is as yet in its swaddling clothes and has only just cut, metaphorically speaking, its first teeth. True it is, that the dried fruit industry, which, by the way, is almost as old as the immemorial hills, is established on a firm basis, but the dehydration of the common or garden vegetables, as potatoes, cabbage, spinach, onions and so forth, has not found favor in the eyes of the people at large. The reason for this is that the man in the street does not understand the situation and is either indifferent to dehydrated foods or is mildly and ignorantly prejudiced against them. If he could be taught the significance of modern dehydrating methods and be shown that dehydrated foods are superior to canned or cold storage foods—in fact, almost identical with the products in a fresh state—and that only by the dehydration of vegetables can conditions be handled successfully, he would assuredly alter his attitude toward this question.

Here are some further reasons why dehydrated vegetables fill a place which cannot be filled by vegetables subjected to any other preservative process.

First, some dehydrated vegetables, when scientifically prepared, retain their original flavor more fully than when canned in the usual fashion. Two of the most important of the canned American vegetables, corn and string beans, are outstanding examples of the truth of this statement. If beans and corn, which have been dehydrated under exactly correct conditions, are soaked and cooked, they retain their natural flavor, which, on the other hand, is much impaired by the ordinary canning process.

As H. J. Burgess(2) has pointed out, some factor in the dehydrating process—possibly oxidation has something to do with it—develops flavors which no other process will develop. All vegetables are not improved in flavor by means of dehydration; generally speaking, however, the flavor of no vegetable is impaired by this process as it is by canning. A lack of understanding on the part of the public as to the merits of dehydration

is largely responsible for the relatively slow progress of the industry. In order to render the public more cognizant of the economic and other obvious advantages of dehydration, especially of the dehydration of vegetables, it will be necessary to induce housewives to take an intelligent interest in the matter. This result will only be brought about by the prosecution of a publicity campaign showing the advantages of dehydration and popularizing food products treated by this process.

We have dwelt upon and endeavored to drive home as forcibly as possible the potentialities of a universal system of dehydrating vegetables, because vegetables best lend themselves to the method. We feel convinced that if this means of preserving them is generally adopted, a great advance will have been made in economizing and conserving the food supply as well as in providing a reserve of nutritive foodstuff in case of need. The details of the dehydration of vegetables will be exhaustively dealt with at the end of this chapter.

The dehydration of fruits is a long established industry, as is also the drying of meat; desiccation of milk has been carried on during a period of several years. These subjects, therefore, will only be discussed under their several heads.

APPLICATION OF DEHYDRATION TO SPECIAL FOODS

DESICCATION OF MILK

With regard to the desiccation of milk, it may be said that the practical process of converting cow's milk into dry milk powder is a comparatively recent discovery. Attempts were made in the middle of the last century to condense milk to a stage of dryness; these resulted in failure. According to Levi Wells(3), a consular report from Sweden, dated November 20, 1901, refers to a process reported to the Academy of Agriculture, a meeting of which was held in Stockholm in that month. The *New York Produce Review and American Creamery*, January 1, 1902, comments on a similar process used in America, and claims that it was discovered prior to the Swedish process.

Historical Development of the Process.—Dr. Eric Pritchard(4) states that in the year 1903 Mr. S. Amundsen succeeded in employing on a commercial scale a method of desiccation invented a few years previously by Dr. G. Ekenberg. Dr. Pritchard is the greatest authority on dried milk in Great Britain, and one of the first in the world. In the course of the following account of desiccated milk, his work just referred to will be largely drawn upon for facts and views. The establishment of

Mr. Amundsen's factory in Christiania was almost the necessary consequence of the fact that in this part of Sweden the butter industry, entailing a large and unavoidable loss of by-products and residuals, was of considerable importance. The outcome of this condition was the invention of the Ekenberg process. At first this process was by no means an unqualified success, chiefly because the method could be used only for the desiccation of milk from which the butter fat had been extracted. However, in the course of time the Ekenberg system was so greatly improved that manufacturers were able to produce desiccated milk on a commercial scale without the preliminary removal of the cream.

Present Methods.—So many improvements have since been made that at the present moment there are, according to Pritchard, three distinct methods of manufacture, each good in its way and each possessing special advantages. Levi Wells, on the other hand, says that there are two distinct methods of drying milk from which several systems have been evolved.

EKENBERG PROCESS.—As described by Pritchard, the Ekenberg process consists in the partial condensation of milk at a low temperature under reduced pressure, and its subsequent desiccation within the interior of cylinders heated to a comparatively low temperature. The milk solidifies into a crystalline mass on the surface of the cylinders, which are kept in constant rotation. This mass is subsequently broken up and pulverized. The method is largely employed in France and in other parts of Europe.

JUST-HATMAKER PROCESS.—In Great Britain the method usually employed is that known as the Just-Hatmaker process. In this method the previously concentrated milk is spread on the outer surface of rotating cylinders, which are heated to 160° C. by steam. The thin film of milk dries very rapidly on the highly polished surfaces, and when dry is scraped off by sharp knife blades and subsequently pulverized as in the Ekenberg process.

BEVENOT DE NEVEU PROCESS.—A third process, generally known as the Bevenot de Neveu method, consists in concentrating the milk in vacuo and at a low temperature, and then forcing it under high pressure, 250 atmospheres, through minute perforations in a metal disk into the drying chamber. The nebula of homogenized milk is then surrounded by an envelope of dry hot air and swept across the chamber. Owing to the fine state of division of the particles in which the condensed milk is presented, and to its intimate contact with dry air, the milk is almost instantaneously desiccated, and falls as an extremely fine powder to the

floor of the chamber. The moisture thus evaporated is carried off as a cloud of steam, while the snow-like desiccated milk is rapidly swept up from the floor and packed in tins or other receptacles.

The rapidity with which the concentrated milk is evaporated in the drying chamber is the distinguishing feature of this method. So swift is the evaporation that the water is removed from the coagulable ingredients, such as the whey products, before they have time to become coagulated by the heat. In fact, the coagulable substances which have been so desiccated can be reconstituted by adding water.

By the Bevenot de Neveu process milk and whey can be reduced to a very dry powder containing no more than 1 per cent of water, apparently without alteration of their physical properties; that is to say, none of the enzymes or vitamines appear to be destroyed. The milk, when reconstituted with water, can be coagulated by rennet or heat, precipitated with acids, and soured by lactic acid ferments, just as is the case with milk fresh from the cow. Moreover, when allowed to stand, the cream will slowly rise as it does in fresh milk which has been homogenized. As Pritchard says, these results are in his opinion very valuable, for they refute the chief argument usually brought against desiccated milks—that they are so profoundly altered by the heat to which they have been subjected in the course of manufacture that they no longer possess those subtle and vital properties which are supposed to be essential to good nutrition.

If the results of the Bevenot de Neveu method of desiccating milk are as Pritchard thinks they are, and he is a close and trained observer, and if none of the enzymes or vitamines are destroyed, the process is an excellent one. The odor, however, of the Bevenot de Neveu milk is slightly tallowy, due to the oxidation of the fat, a result which seems to follow from the fine state of division in which the fat particles are presented to the oxygen of the air. While this oxidation in no way impairs the nutritive value of the milk, it detracts, of course, from its popularity. This is unfortunate, as in all other respects it is superior, in Pritchard's opinion, to other varieties of desiccated milk.

STAUF PROCESS.—Robert Stauf, of Posen, Germany, devised a process for producing dry powders from blood, milk, etc., by atomizing these liquids into supplementary regulated currents of heated air. The amount of air and heat supplied was sufficient to completely absorb and vaporize the moisture of the liquid. The resulting dry powder was separated from the moisture-laden air by means of a screen. The screen retained the powder and the air passed off through the screen. The Stauf process was

the first spray-drying process to be commercially used in the United States.

Comparison of Kinds of Desiccated Milk.—The appearances of the cylinder-dried and air-dried milks are distinctive. The color of Just-Hatmaker milk is biscuit yellow, that of Bevenot de Neveu milk of a peculiarly snow-like white. When allowed to stand, the fat rises in the former as a yellow oil, in the latter as a rich cream. The odor of the cylinder-dried milk is agreeable and distinctly biscuity.

Fatless Milk.—Levi Wells is of the opinion that drying milk from which the fat has been removed seems to be a success. Milk is changed by the drying process from a quickly perishable, bulky substance, inconvenient to transport, into a product requiring little space. Its keeping properties are practically unlimited, and, furthermore, it is a safe food, free or almost free from hurtful germs.

According to Wells, probably over 90 per cent of the milk powder produced at the present time is made of skim milk. From one hundred pounds of whole milk of average quality, 3.5 pounds of butter fat and nine pounds of dry skim milk can be secured. Dry skim milk powder has the appearance of ordinary flour made from grain. This grade of dried milk possesses in a condensed form all the valuable properties of fresh, sweet, skim milk. It can be used in this form by bakers and confectioners, or, if desired, it can be converted into its original liquid state by adding the amount of water that has been extracted from it. Wells is not so enthusiastic concerning desiccated whole milk. He undoubtedly refers to America when he states that most of the milk desiccated is skim milk, as Pritchard, although he writes solely on infant feeding, points out that in Great Britain dried milks, whether prepared by the cylinder or the air process, are usually sold in three qualities: "full fat" milk, from which no cream has been extracted before drying; "half cream," from which part of the fat has been removed; and as desiccated milk, from which all the cream has been separated.

Reconstruction of Desiccated Milk for Infants.—If it is desired to reproduce undiluted cow's milk, it can be accomplished by prescribing so many ounces of the reconstituted dried milk made up in the proportion of one dram of the powder to one ounce of water, and modified for infant consumption. If dried milk is to be modified to correspond to breast milk in all its constituent parts, including its content of whey products, these latter must be added independently.

The Bevenot de Neveu process of desiccation produces a whey powder which when reconstituted with water almost exactly reproduces the orig-

inal whey from which it was prepared. By an appropriate combination of dried milk, whey powder, sugar and cream, a humanized milk can be prepared which has a percentage composition the same as human milk, namely—caseinogen, 0.5 per cent; whey proteins, 1 per cent; sugar, 6.5 per cent, and fat, 3.5 per cent. The formula is as follows:

Full Cream Dried Milk..........	3	teaspoonfuls
Dried Whey Powder.............	2½	tablespoonfuls
Sugar	2	teaspoonfuls
Thick Cream	1	oz.
Water to	1	pt.

This is a very valuable substitute for breast milk.

Strong, healthy infants, who have been accustomed to take ordinary cow's milk, or who have been gradually accustomed to larger quantities of caseinogen by a graduated course of feeding, thrive well on a mixture of the following formula: proteins, 2.5 per cent; sugar, 6.5 per cent; fat, 3.5 per cent. This is prepared by combining:

Full Cream Dried Milk.................	2	oz.
Sugar	½	oz.
Thick Cream	1½	oz.
Water to make the pint		

For the feeding of poor infants and for the sake of economy, Pritchard uses desiccated separated milk, which he modifies by adding supplementary fat and by sweetening with a small quantity of sugar. He employs as a fat an emulsion of linseed oil. The formula for preparing 20 ounces of separated dried milk and an emulsion of linseed oil is as follows:

Separated Dried Milk	1½	oz.
Emulsion of Linseed Oil (50 per cent fat)..	1½	oz.
Sugar	½	oz.
Water to make pint		

Advantages of Desiccated Milk.—Pritchard believes with Professor Porcher that desiccated milk is *"la vache dans le placard."* If you have dried milk, you are as well off as if you kept a cow in the larder ready to be milked at any moment. Dairy milk deteriorates and is liable to infection almost from the moment it is milked up to the moment of consumption. Desiccated milk represents milk which has only deteriorated between the time of milking and desiccation. This time may be short. The range of usefulness of desiccated milk is obviously a wide one. It

possesses many advantages. Its keeping properties are to all intents and purposes unlimited; it is easily transported; it is convenient to handle and is ready for immediate use under any circumstances and at all times; it is sterile; and its cost is somewhat less than the dairy milks. When the desiccation is properly done, the nutritive properties of the milk are preserved. Skim milk is more easily and successfully desiccated than milk from which the fat has not been removed, yet whole milk can be desiccated with success, although its keeping properties are not equal to those of dried skim milk. For the various reasons already given, desiccated milk is especially well adapted for use in armies, hotels, restaurants, boarding houses and hospitals. As the public gains a better conception of its value, its use is certain to be greatly increased.

The average composition of whole milk powder is as follows: solids, 96.3; ash, 5.6; fat, 26.8; protein, 32.0; lactose, 31.9. Analysis of skim milk powder shows solids, 91.7; ash, 6.9; fat, 1.7; protein, 33.8; lactose, 49.3.

DEHYDRATION OF CASEIN

According to Cautley(5), dried casein is a very nutritious food, on a par with the cheese made from skim milk. It is enormously valuable in that it can be added to other foods, thus enhancing their protein value. Casein is purin free, does not clot and is easily digested and absorbed. *It is indicated in all affections in which additional protein is needed, and is useful as a means of giving phosphorus in organic combinations. It is especially valuable in the treatment of acid dyspepsia, for the protein fixes the acid.*

DRIED EGGS

Special investigations of the freezing and drying of eggs and of the two general methods in use for preserving eggs when removed from their shells have been made by Pennington(6), and by Stiles and Bates(7).

There is no doubt that the drying of eggs is an economically desirable procedure provided that the eggs are fresh and wholesome and that they are handled with care.

Pennington has pointed out that the handling of eggs from which the shells have been removed is analogous in many respects to the handling of milk, and should be characterized by the most scrupulous cleanliness from beginning to end. Bacteriological investigation will best demonstrate the sources of contamination, which can be eliminated almost wholly by the adoption and enforcement of strict sanitary measures, such as cleanliness of surroundings and of the workers, frequent cleansing and drying

of the fingers, use of appliances and containers which have been thoroughly sterilized, and prompt drying of the egg after the shell has been removed.

According to Stiles and Bates, the drying of eggs expels over nine-tenths of the water originally present. One pound of the dry product represents the solids of from 36 to 40 average-sized eggs.

Stiles and Bates describe four general methods of drying eggs in commercial use. Of these methods the following, known as the "instantaneous method," is perhaps the most satisfactory. The liquid eggs are sprayed into a heated chamber at a temperature of about 160 F., where they are immediately reduced to a fine powder which usually contains from 3 to 5 per cent of moisture. This powder is carried by currents of air through cotton bags or other filtering devices, and finally falls into bins, ready to be packed in suitable containers. Other processes of drying eggs are known as the "Belt" method, the "Disk" method and the "Tray" or "Board" method. Egg substance thoroughly dried, preferably by the instantaneous process, will keep in a satisfactory condition in almost any climate, for an unlimited period of time and retain all the nutritive value of the fresh egg.

Stiles and Bates, as the result of many experiments to determine the bacterial content of frozen and dried fresh eggs, came to the following conclusions: Under normal conditions, strictly fresh dried eggs contain few if any bacteria, and no appreciable numbers of B. coli in 1 c.c. quantities. Consequently, it may be stated that if the eggs are fresh, if all the necessary sanitary conditions are fulfilled when preparing them for drying, and if the instantaneous method is employed, the eggs thus treated will preserve their nutritive properties for an indefinite length of time and will constitute an important reserve supply of food.

THE PRESERVATION OF MEAT BY DEHYDRATION

Ancient and Modern Methods of Drying Meats.—The drying of meat is a very ancient custom. Almost as soon as our prehistoric ancestors were enabled by means of hunting to gratify their natural instinct for animal food, they preserved some of the meat or fish thus obtained by drying it in the sun and then storing it. Even before flesh food was known to them, they were accustomed to dry insects in the sun, and many of the primitive peoples still existing follow similar customs.

In the dry climates of South America or of South Africa, and on our Western plains, meat is cut into thin strips and hung out of doors to be exposed to the direct action of the sun's rays. In a short time the moisture

has disappeared and the hard, dry pieces will keep indefinitely, or, at any rate, as long as they are kept dry. The meat retains a fair degree of palatability and practically all of its nutritive properties. In the West this is known as "jerked beef," and in South Africa as "biltong." "Pemmican," a food largely used by explorers, is a mixture of dried lean meat, fat, and sometimes dried fruits, such as currants and raisins.

TELLIER METHOD.—Drying is not so well adapted to meats as to vegetables and fruits. Dried meats lose, to a considerable extent, their natural flavor. Perhaps the best method of preserving meat by dehydration is that devised by the celebrated French refrigeration engineer, Charles Tellier, who has described the process in his book, "La Conservation de la Viande." A. F. Burger(8) gives an account of the method. By this process the meat is dehydrated in vacuo, without the employment of heat or the use of any agents which might alter its properties, as is the case when meat is preserved by pickling or by drying with heat. Meat dehydrated in vacuo loses most of its water and retains its natural properties. Its culinary properties are not prejudicially affected nor is its nutritive value impaired, since no essential alteration of the tissue or of the juices occurs.

The degree of vacuum to be applied in removing the water should be as near absolute as possible; in any event the pressure remaining in the evaporating chamber should not be above 4 or 5 millimeters of mercury and the vacuum should be kept up for 12 to 24 hours. The method employed by Tellier was as follows: An apparatus is constructed, consisting of two strong cylindrical containers, each surrounded by a water jacket for the purpose of maintaining a desired temperature. These two receptacles are connected by a pipe passing out at the top. The larger of the two vessels is filled with the meat to be dried, placed upon trays. The other vessel is filled with coke or other inert spongy, porous material which is kept wet by a solution of caustic potash.

After the air has been drawn out of the system by means of an ordinary air pump, carbonic acid gas is turned in and later removed by the pump. This procedure takes out the last traces of air. The residue of carbonic acid gas is then absorbed by the caustic potash solution which impregnates the coke, the result being a very perfect vacuum. The process is said to be inexpensive and to require but little hand labor. Three advantages of the method are stated. (*a*) The meat preserved in this manner keeps even when exposed to the air. For all practical purposes it is sterile, since the organisms contained therein are either killed by the dehydration or are so weakened thereby that they cannot vegetate or multiply

on account of the lack of moisture. (*b*) Having been cut into suitable pieces before preparation, it may be easily handled in small shops. (*c*) Meat thus treated can be much more easily transported than fresh meat.

POWDERED MEATS.—Powdered meats are prepared by complete desiccation, and products of this nature are found upon the market in a finely ground form. Meat powders are made from fresh meats in their natural state and also from artificially digested meats.

ITALIAN METHOD FOR POWDERING MEAT.—Some four years ago an Italian inventor perfected a process for preparing beef meal. Meat treated by this process is said to retain the characteristic taste and aroma of ordinary beef. By this process the beef is dried at a low temperature; that part of the vapors which contain the aroma substances is collected, condensed and added to the dried beef after the latter has been properly ground. Beef prepared by this method is said to have unlimited keeping properties. It can be used in exactly the same way as ordinary beef for soups or in combination with vegetables.

DISADVANTAGES OF MEAT IN POWDERED FORM.—Dehydration of meat or its reduction to powder, however, *impairs its flavor and renders it less palatable.* In consequence, meat treated by these processes is not likely to become widely popular. Circumstances may occur in which dehydrated or powdered meat may be extremely useful, indeed, almost essential, but in everyday life dehydrated or powdered meat will not have a vogue. The dehydration of vegetables, on the other hand, will probably revolutionize the food situation. It is mainly this form of dehydration, therefore, that will be discussed most exhaustively and upon which emphasis will be chiefly laid in our consideration of the subject.

DRIED FISH

A good deal of fish is sun-dried, but at present there are no artificial modes of dehydrating fish. An immense quantity of fish is cured and incidentally dried, but this is not dehydration. There is a dried fish powder made in Greenock from white fish, mainly protein; dehydration, however, is not usually applied to fish.

DRIED FRUITS

The drying of fruits is an extremely ancient procedure. It was the custom in primitive days and by primitive peoples for fruits to be preserved by extracting the moisture or a large proportion of the water content, through exposure to the action of the sun. It appears likely that

fruits were first dried in warm countries, but the custom has long prevailed among the inhabitants of temperate and northern latitudes. In this country the drying of fruits has been practiced since the first coming of white men. Dried apples and berries were factors of much importance in the winter bills-of-fare of the early colonial settlers as they had been in the winter supplies of the Indians. The methods of drying, however, were crude, and in consequence, the dried product was poor and by no means uniform in quality.

Sun-drying.—Sun-drying of certain fruits, when carefully done under favorable conditions, is productive of excellent results. For example, raisins and figs are dried better in the sun than by artificial methods. The weather, of course, plays an important rôle. It must be borne in mind, however, that fruit is often subjected to contamination in the open air. It is a matter of common knowledge that disease-bearing microorganisms of various kinds, as well as minute organisms which cause decay in the fruit, may be carried in the blowing dust. Moreover, insects attracted by the fruit may deposit their eggs on it. Such possibilities can be guarded against, to a large extent, by selecting clean and well-protected out-of-door drying places, by avoiding careless and unnecessary exposure of the fruit, by washing or sterilizing—in fact, by taking every needful precaution.

Artificial Drying.—During recent years the methods of artificial drying and the machinery employed for the purpose have been so greatly improved that this mode of preserving fruit has largely supplanted the time-hallowed ways, in the case of apples, apricots and peaches, at any rate, and indeed for most of the fruits grown in the northern parts of America and in Europe. The greater cost of artificial methods is more than offset by the saving of time and labor. The superiority of the artificially dried product in cleanliness and uniformity of the fruit is so obvious as to require no emphasis.

These improvements, furthering the great development of the dried-fruit industry in the United States in recent years, have resulted largely from the investigations and the efforts of the U. S. Department of Agriculture and of the agricultural experimental stations. Consequently, the large fruit-drying establishments, numerous in the fruit-growing sections of this country, which are distinguished by high standards of cleanliness, are reaping the reward of their foresight. The subject matter of this essay on dried fruits is partly gathered from a bulletin in the Year Book of the Department of Agriculture(9) and Farmers' Bulletin(10) of the same department.

The preparation of dried fruits for the market involves a great deal more ingenuity and thought than is usually imagined. It is not a simple matter, for although methods vary in different districts and for different kinds of fruits, they are one and all founded on a scientific basis, and as Langworthy aptly remarks, "The producer who understands the scientific reasons for all these processes has the advantage of being able to apply them more accurately and economically, and thus to get a better and more uniform product even when crops and weather conditions are poor"(9).

As a rule, nowadays, fruits are dried without the addition of any foreign substance. With regard to the terms used to describe the preparation of fruit products under discussion, the appellations, drying, evaporating, desiccating and dehydration are all more or less applicable. We have employed the term dehydration at the head of the chapter, and although there may be fine and nice distinctions qualifying the exact significance of this term, after all, it is removal of water which constitutes the principle of the process. Dehydration accurately means drawing off moisture. However, in the case of fruits, "dried fruit" is the broadest and most appropriate term. The various methods used have the same object, the drying of fruits in such a way that they shall retain as much of the natural flavor and nutritive food properties as possible, and at the same time have an attractive appearance, be free from contamination of any description, and, above all, possess good keeping qualities.

On the whole, the modern methods of rapid drying produce fruit better in flavor, color and texture than fruit dried at home in the old-fashioned way. Some think that a better flavor is obtained by sun drying, but that rapid, artificial drying imparts a better color. The weight of evidence, however, for the majority of the fruits, the most notable exceptions being raisins and figs, is in favor of rapid artificial drying.

The consumption of dried fruit in this country is very large and is increasing; the exports also are very important, showing, from all points of view, that the industry of fruit drying is in a remarkably healthy condition. California easily leads in the production of dried fruits. More than 80 per cent of the total amount comes from that state. The present output of dried fruits in this country is in excess of 500,000,000 pounds annually.

Dried Prunes.—Up to quite recent times apples were the chief fruit dried in this country. Recently, however, while the quantity of apples so treated increases slowly, the drying of raisins, prunes and peaches progresses by leaps and bounds. As long ago as 1909, statistics showed that about 12,000,000 pounds of dried apricots, 44,000,000 pounds of dried

peaches and 115,000,000 pounds of prunes were consumed in America alone. More and more of these fruits are being dried each year. Prunes, peaches, apricots and cherries, belonging to the same botanical family, are subjected to much the same kind of process, so that a description of the methods used for drying prunes will exemplify the manner in which similar fruits are dried.

PREPARATION OF FRUIT FOR DEHYDRATION.—It is needless to explain that prunes are dried plums. Everyone, however, does not know that American California and Oregon plums, in particular, are fast taking the lead as the main sources of prune products. In order to have the finished product in the very best condition, the greatest care must be taken not only in the carrying out of the process itself, but in the prior preparation of the fruit. In the first place, the gathering should be done most carefully, the fruit should be picked by hand or shaken gently upon sheets spread under the trees, the object, of course, being not to bruise them. If the plums be not perfectly ripe, they should be exposed to the rays of the sun for a day or two, so that their natural sugar content may be increased and their water content diminished. The fruit is then graded according to size to render the drying more uniform. Cleaning the fruit is the next step, followed by treatment of the skin in such a way that the water will be all the more quickly evaporated from the interior. Dipping the fruit in boiling water is sometimes thought to sufficiently answer the purpose; but more frequently this simple method is supplemented by pricking the skins with a special apparatus, by dipping the fruit into lye, or by placing the sorted prunes into perforated metal baskets which are dipped into a hot 0.75 per cent solution of potash. The fruit is only kept in this solution a very short time, just dipped in and out, and immediately transferred to cold water. This is necessary to prevent the prunes from acquiring an alkaline taste. The alkaline bath removes the thin coating of wax, the so-called bloom, which would interfere with the passage of the water through the skin when the drying process is in progress. California prune dryers use a soda in preference to a potash solution. Having expedited the evaporation of water from the interior, and having washed the alkali free, the fruit is ready for drying.

When the climate is suitable, and the weather permits, prunes are sometimes dried in the open air, or in ordinary drying sheds, but most frequently artificial means are resorted to, to hasten the process.

As said before, the question of the best and most rational method of preparing dried fruit cannot be answered offhand or in general terms. Local conditions largely determine this matter; the amount and the kind

of raw materials available are the most important factors involved. Sun-drying in California usually requires from one to two weeks, and artificial drying a considerably shorter period of time—the ordinary American method requiring from twenty-four to forty-eight hours, according to the character of the fruit.

METHODS OF DEHYDRATION.—At the present time there are three principal systems used by those engaged in the fruit-evaporating industry: first, the old method of drying in a hot chamber under ordinary atmospheric conditions; second, the vacuum system, by which the fruit is dried under diminished atmospheric pressure; and third, the dehydrating system, in which the fruit is dried by warm air which has been previously cooled at a low temperature so as to deprive it of the moisture which it might contain. The advantages claimed for this latter system are that the fruit can be dried at a much lower temperature than is possible otherwise, because the air being quite dry, can take up large quantities of moisture without requiring to be heated. It is also more rapid than the other processes. As stated in the remarks on the dehydration of vegetables, this method does not injure the cellular structure and consequently vegetables and fruits treated by this method retain to a remarkable degree their contour and full flavor when prepared for the table.

Dried prunes are "sweated" for two or three weeks and then regraded according to the number required to make a pound. After grading they are finished or "glossed" by heating in steam or immersing in salted boiling water, fruit juice or glycerin, by which means the exterior is sterilized and a shiny surface is imparted.

Dried Peaches and Apricots.—Peaches and apricots are usually pitted before drying. After using the same care in gathering these fruits as in the case of plums, in order to avoid bruising, they are then promptly prepared for drying. When peaches are peeled before drying, they are usually dipped in hot lye to loosen the skin, but apricots are almost invariably dried with their skins on. When the fruit has been pitted and cut, it is laid in trays. When sulphuring is practiced, a method which will be described briefly when the evaporation of apples is discussed, it takes place at this point. The drying proper then follows.

OLD-FASHIONED METHOD OF DRYING FRUIT.—The following household method of drying peaches and plums, which was prevalent in the old days, is still practiced in the Southeastern States. The fruit is peeled, pitted, mashed, spread out in a thin layer, and dried in an oven or in the sun until the mass is tough and resembles leather in appearance. The name given to it is peach or plum leather, and it is said to keep indefi-

nitely, even if only packed in bags. Stone fruits are sometimes preserved by housekeepers. The fruit is pitted, sprinkled with sugar, placed in an oven moderately heated, kept there until the oven is hot and afterwards dried slowly in the sun or in a cool oven.

Dried Apples.—Apples have been artificially dried in this country, at least, on a large scale for a longer period than any other fruit. A large quantity of apples is still dried in primitive fashion. In country districts in which apple cultivation is not carried on extensively, there is frequently to be seen during the autumn, apples sliced or quartered for drying in the sun, placed on a flat rock, on the roof of a low shed or on any easily available flat surface. While, perhaps, the greater part of this sun-dried fruit is intended for home consumption, a good deal of it is sent to the market and some is exported.

According to H. P. Gould, the average weight of ripe winter apples of mixed varieties is about fifty pounds to the bushel. In evaporating them some forty pounds of water per bushel, or approximately five gallons, passes off in the form of vapor. The object of the process is to draw off, as rapidly as possible by artificial means, sufficient moisture to prevent deterioration through decay or other natural means, and at the same time to maintain a desirable texture and flavor.

More apples are artificially dried than any other fruits, because they are grown more largely in temperate climates. In many of the lands in which apples flourish, the changeableness of the weather renders sun drying out of the question, hence evaporators are numerous. Some are situated in villages near railroad stations or in a central and easily reached locality. Many are erected in or about the orchards themselves. The largest evaporators, generally placed in towns or villages, are operated by men who make a business of evaporating; consequently these plants are of larger capacity and are better constructed in every respect than those in the orchards.

It would be superfluous to enter here into a detailed description of the various kinds of evaporators in use. The brief description given a few pages back of the three chief systems for dehydrating fruits will suffice.

Dried apples are produced on a large scale, in three principal forms: whole apples, consisting of the smaller fruits which have been peeled and the core removed; split apples, made from larger fruit which have been peeled, the seeds removed, and the fruit split lengthwise in six or eight sections, and "ring apples," made from large fruit, which after peeling and removing of the core, are cut across the core hole into thin flat disks.

It must always be borne in mind that the success of the process of drying apples depends mainly on the kind of fruit used. Of course, the primary economy of evaporating fruits is in utilizing the surplus fruit and poorer grades of fruits, which would otherwise be wasted. Consequently, it is this sort of fruit which is usually dried. Nowadays, however, there is an increasing demand for dehydrated apples of the best quality.

An important point which is often overlooked in the selection of apples for drying, is the fact that the varieties of apples differ considerably in the amount of substance they lose in peeling and coring, and in the weight of dried fruit they will give. Water constitutes the greater part of the weight of an apple. Some kinds of apples contain more water than others, and the water content of the same variety of apples will vary, in some degree, according to the season and weather.

Complicated machines which peel, core and sometimes even slice the apple at one operation are in general use. After these operations are completed, the apples are as a rule dipped for a few minutes in a weak solution of salt and water to prevent the discoloration brought about in several varieties of apples by the action of the oxygen in the air. The fumes of burning sulphur are employed not only to achieve the same object, but to prevent further discoloration after the apple has been sliced, and to render the color lighter. The method is also supposed to be necessary to kill moths, insects, fungi or hurtful microörganisms. Bleaching by sulphur should be employed immediately after the surface of the apple has been exposed to the air by paring. On being removed from the dehydrator the fruit should be allowed to stand for the "sweating" to take place, a process which generally lasts for several days and which should be carried out in the open air or in well-ventilated rooms.

The proper storage of the dried fruit is important because if brought into a damp atmosphere the spongy cells will absorb additional moisture which may accumulate to such an extent as to again make the fruit a favorable medium for the growth of bacteria.

Raisins.—The amount of raisins produced in this country is enormous. The methods of curing the grapes depend partly upon the purpose for which the dried products are intended. The smaller varieties of grapes are used for making raisins for cooking purposes, and only the best quality of the larger varieties can be dehydrated to make good table or layer raisins. Bunches of the latter are first carefully picked over, and the dried or unripe fruit discarded. The bunches are then placed on trays in the sun. The smaller sultana, the currant varieties and the less attractive bunches of grapes of the larger varieties are dipped in weak lye before

they are dried in order to soften the skins slightly and loosen the stems which are removed before the raisins are packed.

Other Dried Fruits.—In days gone by, strawberries, raspberries, blackberries, blueberries, barberries, currants and most small native fruits were frequently dried at home. This practice has greatly fallen into disuse since dehydration and preserving have come into vogue, but still exists in a few regions, notably in the mountains of Tennessee, where dietary studies made by the Department of Agriculture showed that these dried berries were used as staple foods.

Dates are cured in this country, the date palm having been introduced and found to ripen well in Arizona and neighboring regions, but as yet the industry is in its infancy.

While the fig tree can be grown in any mild climate, the varieties suitable for drying can be produced only under special conditions. However, most of the difficulties in this direction have been overcome. In California, the Smyrna fig has become naturalized, and the dry fig industry in that state is assuming goodly proportions.

Bananas.—The banana is not dried in this country, but as it is regarded from nearly all standpoints as the most nutritive of fruits, it will be pertinent to deal somewhat briefly with the drying of bananas. Jamaica has been, so to speak, the mother of the dried banana industry, and it is on this island that the majority of the really important factories for drying bananas are now to be found. There are several factories for the same purpose in the Philippines. The drying of bananas is done by hot air. The larger pieces of dried banana are generally known as "banana figs."

DRIED BANANA PRODUCTS.—The dried food products made from bananas are "banana figs," cooking bananas, banana chips and banana flour and meal. All the factories in Jamaica dry or evaporate the bananas whole without the addition of sugar, and yet they are as sweet and palatable as pressed figs. Cooking bananas are so thoroughly dried as to be quite hard. Their color is almost white. When broken into pieces, they are known as banana chips and are exported to be ground into meal or flour. All banana foods are wholesome and nutritious, and, owing to the large yield of the fruit and its high carbohydrate content of sugar and starch, bananas have long been recognized as a very cheap food, although their value from the nutritive and economic standpoints is not yet fully appreciated. "Banana figs" are delicious, and cut into small pieces may be used like raisins to impart an additional flavor to cakes and puddings. The chips after having been well pounded or ground in a coffee or other

hand mill, may be boiled and then used as an excellent breakfast food or for making puddings. Gruel, porridge or other preparations made from banana meal or flour, which is rich in easily soluble carbohydrates, are recommended for infants, invalids and dyspeptics. It is said that the negro women of Jamaica use banana meal gruel as a substitute for milk for their infant children. An inexpensive and nutritious bread can be made from banana flour, or the flour may be admixed with other ingredients to make a wholesome and cheap bread.

Unusual Dried Fruits.—The better qualities of the meat in the interior of the cocoanut seed, commonly known as copra, is desiccated. It is used mainly for flavoring and garnishing purposes in the countries into which it is exported. There are several other dried fruits, some of which are grown and dried here, but most of which are imported. Among these the following may be mentioned: *olives* from the eastern Mediterranean region, where they are eaten as a staple food; *dried cactus fruit,* in the southwestern part of this country, in Mexico and in lands abutting on the Mediterranean; and *dried chestnut,* much used in European cookery and now fairly prevalent in America. In China may be found the lichi nut or *Chinese raisin.* The *jujube* is common in China and Japan, but is little known here except in the form of jujube paste. There is also the carob bean or St. John's bread, the dried pods of a European locust bean.

Of Chinese and Japanese fruits available for drying, the persimmon is the most suitable. In some districts of China strains of *persimmon* are found which are being grown for drying purposes only. A dried persimmon in appearance and flavor resembles a dried fig with the exception that it is devoid of small seeds, and is covered with a heavy layer of fine grape sugar. The cultivation of persimmons for drying purposes is a growing industry in China, where thousands of acres are devoted to this purpose. Hundreds of varieties exist, and the trade in China of dried persimmons compares in importance with our trade in dried peaches.

Comparison of Food Value of Fresh and Dried Fruits.—The food value of dried fruits is naturally their most important characteristic, although a pleasing flavor is an extremely desirable adjunct, as is also their acid content, which is believed to aid digestion. The flavor, the aroma and the appearance act as stimulants to appetite and, according to present-day views, influence the secretion of the gastric juices.

The flavor of dried fruits is seldom if ever the same as that of fresh fruits, but as mentioned before, fruits dehydrated by the most recent American process retain to a very considerable degree their fresh taste and flavor.

A pound of fresh fruit will yield on an average about six ounces dried. The food value then of one pound of dried fruit is greater than that of the same weight of fresh, since it has been concentrated by evaporating the original water content.

It goes without saying that the nutritive value of dried fruits, as of other foods, in the first instance, depends upon the proportion of food ingredients therein contained, and in a general way the food value is in inverse ratio to the water content. Analysis has demonstrated that dried fruits which contain from 15 to 30 per cent water—and by the most modern methods of dehydration a good deal less water remains—are relatively so much the more nutritious than fresh fruits, of which the water contents average anywhere from 75 to 95 per cent.

The following table will show the average composition of dried fruits and fruit products:

ANALYSIS AND CALORIC VALUE OF DRIED FRUITS (PER POUND)

Fruits	Refuse, per cent	Water, per cent	Protein, per cent	After extract, per cent	Edible Portion			
					Nitrogen free extract, per cent	Crude fiber, per cent	Ash, per cent	Fuel value per pound
Apples	...	26.1	1.6	2.2	62.0	6.1	2.0	1,350
Apricots	...	29.4	4.7	1.0	62.5	...	2.4	1,290
Bananas	...	29.2	5.3	2.3	55.5	2.1	5.3	1,240
Banana flour	...	9.7	3.1	.5	83.4	.7	2.6	1,610
Citrons	...	19.0	.5	1.5	78.1	...	.9	1,525
Dates	10.0	15.4	2.1	2.8	74.6	3.5	1.3	1,615
Figs	...	18.8	4.3	.3	68.0	6.2	2.4	1,475
Pears	...	16.5	2.8	5.4	66.0	6.9	2.4	1,635
Prunes	15.0	22.3	2.1	...	71.2	2.1	2.3	1,400
Raisins	10.0	14.6	2.6	3.3	73.6	2.5	3.4	1,605
Raspberries	...	8.1	7.3	1.8	80.2	...	2.6	1,705
St. John's bread	...	17.3	5.7	1.1	67.0	6.4	2.5	1,480
Zante currants	...	17.2	2.4	1.7	71.2	3.0	4.5	1,495

The fuel value per pound of fresh apples is only 290 calories; of apricots, 270; of bananas, 460; of raspberries, 255, and so on.

While the main change that takes place during the dehydration of fruit is the loss of water, other changes likewise occur, varying with the kinds of fruits and the methods employed. In dried fruits, the fact must be taken into consideration that in contradistinction to fresh fruits, the refuse is reduced to a minimum. Moreover, of the small acid content found in fresh fruits, as apples, pears, plums, berries, etc., the greater part remains in the dried fruits. It has been stated previously that the food

value of such fruits is higher the lower the water content. Consequently, raisins, dates and figs having on the whole a less water content than dried apples, peaches and prunes, contain more nutritive material. The food value of fruits, as of vegetables, depends chiefly on the carbohydrates they contain in the form of sugar. Protein is so little in evidence in fruits as to be practically a negligible quantity. Fats, too, need not be taken into account. The mineral constituents of fruits occur in all varieties and are important in that they are necessary for the formation of the fluids and tissues of the body.

As sources of nutrition, and more especially of energy, dried fruits compare rather with cereals and dry vegetable foods than with fresh fruits. In many respects they even compare favorably with the former, although it should not be forgotten that they yield less protein than cereals and legumes and only extremely small quantities of fat. However, dehydrated fruits, some more than others, retain a certain amount of the properties of fresh fruits. For instance, many fruits have a laxative action—indeed they are often eaten for this very purpose, and the effect appears to be equally as potent with dried as with fresh fruits. The manner of dehydrating by the most advanced American methods seems to be not only effective in conserving fruits, but, to a large extent, in preserving their original properties.

Economic Advantages of Dried Fruit.—The economy of dehydrating fruit can be conclusively proven without the least difficulty. It is obvious that dehydrated fruit is economical because it has a higher food value than fresh fruit, and because of the ease by which it can be transported, on account of its keeping properties and its small bulk, thus preventing the sacrifice of surplus supply or fruit of inferior quality. But from the point of view of cost, dehydrated fruits are economical. Even now these fruits may be termed reasonable in price compared with many other ordinary articles of diet. This has been demonstrated by a large number of studies made in connection with the nutrition investigations of the Office of Experiment of the U. S. Department of Agriculture. From these studies, and from information derived from other sources, these conclusions may be with fairness drawn. Since all the fruit products contain little protein, they are more expensive by far than the cereals and dried legumes and most animal foods. On the other hand, as sources of energy, derived almost wholly from their sugars and other carbohydrate contents, dehydrated fruits are a great deal cheaper than meats, compare favorably with dairy products, but are more expensive than cereals and starchy vegetables, as dried beans or potatoes.

So far as a comparison of one dehydrated fruit with another is concerned, that is as regards its food value, the cheaper compare favorably with the more expensive kinds.

The following table will show the comparative cost of total nutrients and energy in some fresh and dried fruits and other food materials at certain average prices in 1907. Since that time prices have advanced considerably, but the comparison will still hold good, except, perhaps, that the price of meat will be relatively higher at the present time than that of dried fruit.

COMPARATIVE COST OF TOTAL NUTRIENTS AND FUEL VALUE OF SOME FRESH AND DRIED FRUITS

Kind of Food Material	Price per Pound	Cost of 1 pound Protein	Cost of 1,000 Calories Energy	Total Weight of Food material	Amounts for Ten Cents			
					Protein	Fat	Carbo-hydrate	Energy
	Cents	Dollars	Cents	Lbs.	Lbs.	Lbs.	Lbs.	Calories
Fresh fruits:								
Apples	1.5	5.00	7.3	6.67	.02	.02	.72	1,467
Plums	3.0	3.33	8.1	3.33	.03	...	.64	1,232
Grapes	4.0	4.00	11.9	2.50	.03	.03	.36	837
Dried fruits:								
Apples	12.0	7.50	8.9	.83	.01	.02	.55	1,121
Dates	10.0	5.26	6.9	1.00	.02	.03	.71	1,450
Figs	15.0	3.50	10.2	.67	.03	...	.50	988
Prunes	10.0	5.56	8.4	1.00	.02	...	.62	1,190
Raisins	10.0	4.35	6.9	1.00	.02	.03	.69	1,445
Porterhouse steak	25.0	1.31	22.5	.40	.07	.07	...	444
Whole milk	3.5	1.06	10.5	2.86	.09	.11	.14	925
Skim milk	2.0	.59	11.8	5.00	.17	.02	.26	850
White bread	5.0	.54	4.2	2.00	.18	.03	1.06	2,430
Sugar	6.0	...	3.2	1.67	...	...	1.67	3,106
Dried beans	5.0	.22	3.1	2.00	.45	.03	1.19	3,210

From a broad outlook, it appears plainly evident that dried fruits are the cheapest of the fruit products and the most economical. Neither fresh nor dried fruits can be rightly regarded as a luxury, since they add considerably to the food value of a diet, and vary the monotony of the daily fare. Dried fruits in sealed cartons or packages are much safer because they are less easily soiled than when sold in open boxes. There is little doubt that the fruit products dehydrated by the most up-to-date American processes are cleaner by far and better in every respect than those subjected to the old-fashioned methods and are superior to the imported varieties.

DEHYDRATED VEGETABLES

Dehydration is absolutely the correct term to apply to the process used for preserving vegetables by withdrawing the moisture which has been developed and it may almost be said perfected in this country.

Importance of Dehydrated Vegetables as Food.—In the introduction to this chapter, stress was laid with intent upon the supreme importance of dehydrating vegetable foodstuffs in such a manner that when prepared for feeding purposes they resemble in all their salient and essential features these same vegetables in their original form. It was pointed out that vegetables thus treated furnished an economical advance of immeasurable value, since vegetables far more than fruits provide all the forms of nutritive material necessary to maintain the human organism at a high standard of health. Some vegetables from their protein content are fairly satisfactory substitutes for meat; others are valuable as foods because of their carbohydrate and fat content. In order to make up a well-balanced dietary and to avoid constipation, that bane of this age, the consumption of a certain amount of vegetables is always indicated.

It is difficult, even frequently impossible, except at prohibitive prices, to procure really fresh vegetables at all times of the year. It is true that one can always buy canned vegetables, but canned goods have their drawbacks. Dehydrated vegetables, when properly prepared, retain their original flavor in a far higher degree than the ordinary canned vegetables and cereals; a few vegetables are improved in flavor by dehydration. The predominating advantages of this process lie not only in the facility and certainty with which vegetables and cereals can be preserved for a great length of time without any clearly perceptible loss of taste, flavor or nutritive properties, but in the ease with which they can be transported owing to their small bulk.

Methods of Dehydrating Vegetables.—It may be stated emphatically that no single device for the preservation of foodstuff excels that of dehydration. Apart from the element of cost, the use of an extreme degree of heat to drive out moisture has the objection that in some cases it so alters the product that it is no longer an agreeable article of diet. Heat also removes desirable volatile ingredients. It may be pointed out that flavors, which play a very important part in rendering a food palatable and acceptable, are, as Mendel shows, not always thermostabile.

The most destructive criticism that can be brought against the use of heat, particularly at high temperatures, as a mode of drying foodstuffs is that high temperatures for a prolonged period are liable to

seriously injure the vitamine element. The presence or absence of this element, in fact, when a diet is restricted to one or two food materials, makes all the difference between health and disease. Therefore it would seem to be the bounden duty of those engaged in the dehydrated food industry to take every precaution not to destroy or injure these "accessory diet factors" known as vitamines. It is stated by those who have had experience with the American process of dehydration that because the heat employed is not intense, and because the time during which the food material is subjected to the process is not long, that the vitamine substances are in no wise prejudicially affected. The main dehydrating characteristics of the system are the comparatively low temperature which insures the retention of all the valuable properties of the food treated and the thorough circulation of the air currents which permeate vegetables or fruits in such a way that most effective dehydration is the result.

Enough has been said as to the system of dehydration best calculated to fulfill the purpose desired, and the only excuse for being somewhat prolix about the matter is that the success of a dehydrating method depends entirely upon its mode of working. If the finished product, to use a rather clumsy expression, is not as nutritive, palatable and attractive in appearance when prepared for the table as the vegetable in its original form, or nearly so, then its other obvious advantages—small bulk and keeping properties—cannot compensate for this lack.

Dehydrated Potatoes.—The potato is, of all the vegetables, the most important. Of the starchy group the common potato easily occupies the first place, both in regard to nutritive value and to the wide range of its cultivation. In this country the sweet potato comes next in popularity, usefulness and consumption. In 1909(11) it was shown that in the average of 376 American dietary studies, potatoes were found to furnish 12.5 per cent, or about one-eighth, of the total food material, and 8.3 per cent, or about one-twelfth, of the carbohydrates. All other vegetables together furnished only 7.8 per cent of the total food and 3.7 of the carbohydrates. The structure, composition and nutritive properties of the potato have been exhaustively dealt with in Volume I, Chapter XIII, therefore it will be superfluous to discuss this phase of the question further. Attention will now be concentrated upon a consideration of dehydrated potatoes, their virtues and drawbacks.

METHODS OF DEHYDRATION.—It may be well imagined that efforts have been made to preserve, in a compact form, a food substance of so great value in the diet as is the potato. This object has been brought

about by drying, which reduces their bulk and prevents decay. The word *drying* is used here intentionally, because dehydration is a recent method, and potatoes have been dried in various ways for a great number of years. The method known as "chunno" is one of the oldest and has been employed in Peru for a very long time. This procedure consists of pressing part of the juice out of the potatoes, which are then dried in the air until they are reduced to about one-fourth of their original weight. Methods of a similar kind have been and are practiced in Europe and America, and while these differ considerably, one of the main objects to be attained always remains the same, namely, the inhibiting of the growth of germs.

As has been pointed out previously, decay is mainly caused by bacteria, which can only grow where moisture and warmth exist, so that, if moisture be removed, growth is inhibited, and the keeping qualities of the potato are prolonged indefinitely.

COMPOSITION OF DEHYDRATED PRODUCT.—The composition of potatoes which have undergone one of these processes is here given, together with the composition of raw and cooked potatoes, for purposes of comparison:

COMPOSITION AND FUEL VALUE OF THE POTATO UNDER VARIOUS METHODS OF PREPARATION

KIND OF FOOD	Refuse	Water	Protein	Fat	Sugar, starch, etc.	Crude fiber	Ash	Fuel value per pound
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Calories
Potato as purchased........	20.0	62.6	1.8	.1	13.8	.9	.8	310
Potato, edible portion..........	...	78.3	2.2	.1	18.0	.4	1.0	375
Potato, boiled...	...	75.5	2.5	.1	20.3	.6	1.0	440
Potato, mashed and seasoned..	...	75.1	2.6	3.0	17.5	...	1.5	505
Potatoes, fried in fat, "potato chips"........	...	2.2	6.8	29.8	46.7	...	4.5	2,675
Potato, evaporated........	...	7.1	8.5	.4	80.9	...	3.1	1,680
White bread.....	...	35.3	9.2	1.3	52.6	.5	1.1	1,215

Naturally, if extreme heat is used in the process, some of the starch content may be changed into dextrin and other minor changes in the chemical composition may take place. However, there is no reason to

suppose that the nutritive value of the potato is decreased by these changes.

Langworthy, in the bulletin referred to above, states that various kinds of desiccated potatoes have been studied at the California Agricultural Experiment Station. Their water content ranged from 4.8 to 7.9 per cent and their total carbohydrates from 77.9 to 80.6 per cent. Their general composition somewhat resembled that of good white flour. They contained slightly less water, slightly more carbohydrates and noticeably more mineral matters. Dehydrated potatoes should be soaked in water before use, in the same way as other dehydrated vegetables. By this means they will regain some or most of their original properties.

POTATO FLOUR.—With regard to the value of potato flour, which, as just pointed out, resembles good white flour: it has been frequently employed in the manufacture of what have been termed "economy breads." The potato is very largely grown in Germany, and in that country the value of the addition of potato meal to wheat flour for the purpose of making bread of a cheaper sort was recognized in 1914 as an economical war measure. In Germany and Austria the bakers were compelled by law to use at least 30 per cent potato meal in making their bread. It has been found, as the result of experiments made by the Bureau of Chemistry of the U. S. Department of Agriculture, that the most satisfactory loaves, combining economy and appearance, were those made with 30 per cent potato meal, or even less. The bread has a rather coarse texture and dark appearance, but is said to possess a distinctive and pleasant flavor. It should be said that the Bureau of Chemistry employed the imported "potato flake" in some of its experiments and in others meal made by slicing, milling and drying potatoes on a small scale in its laboratories.

Sweet Potato.—The sweet potato, from a nutritive point of view, that is, from an analysis of its component parts, is similar to the ordinary kind. It contains rather less water and rather more carbohydrates, and supplies somewhat more tissue-building material, pound for pound. The carbohydrates found in sweet potatoes contain more sugar than in the white varieties, but the proportion of sugar and starch varies with the climate. In hot countries there is more and in temperate climates less sugar.

Dried sweet potatoes were at one time a home product. In days long passed, strings of them might be seen hanging from the kitchen rafters in the company of apples and other dried fruits and vegetables. Modern drying methods and storage warehouses have almost sounded the death-knell of this custom. When sweet potatoes are first gathered, they

are allowed to "sweat" for some time before they are stored. When grown on a large scale they are sometimes "kiln-dried," that is, subjected to a temperature of 90° F. or thereabouts for a week or so. They are then dried more slowly and at a lower temperature in the usual way. Special devices for dehydrating sweet potatoes, in the same way as white potatoes and other vegetables, are now largely used. While the greater part of the sweet potato crop is used for human food, stock are fed with some of the coarser kinds; some also are used for the preparation of sweet potato flour.

Starch-yielding Tubers.—The tubers are sliced, dried and ground. They are also used for the manufacture of starch. There are several tropical starch-bearing roots, as the cassava, yam, yautia and taro. The cassava is very nutritious, and its meal makes an excellent bread which is palatable and wholesome. Analysis of this vegetable shows water content 10.5 per cent, protein 9.1, fat 0.3 per cent, total carbohydrates 79, and a fuel value of 1,650 calories per pound. Yams, often confounded with sweet potatoes, belong to a group of climbing plants. The flours and starches prepared from these differ from wheat flour in that they contain no true gluten.

Beets.—Of the succulent roots, tubers and bulbs, beets are, on the whole, the most important. These possess considerable value as food; directly they are used as vegetable food, also as the source of the sugar supply; indirectly they contribute on a very wide scale to the food of the inhabitants of all the world by furnishing provender for farm animals.

BEET-SUGAR INDUSTRY.—No industry in America is more likely to be revolutionized by the improvements effected in the methods of dehydration than the beet-sugar industry. In 1916 the area used for beet cultivation amounted to 680,000 acres, the beets totalled 6,671,000 short tons, and the production of sugar was in the neighborhood of 900,000 tons. In this country undoubtedly sufficient beets can be grown, and consequently enough sugar can be produced therefrom to make us independent of outside supplies. Many difficulties arising in the manufacture of beet sugar may be wholly or partially solved by dehydration. Where sugar beets are not grown near a factory, the transportation is, generally speaking, too costly to render their cultivation profitable. In the next place, the time for harvesting is short, and in order to preserve the surplus supply, that is, the stock which the sugar factory temporarily cannot deal with, it is frequently deposited in silos. An inevitable loss occurs, owing to fermentation or even to decay of the beets. Also, under existing circumstances, a beet-sugar factory is compelled to remain idle

during some nine months of the year, simply because beets can be supplied to it only for a hundred days or so yearly.

ADVANTAGES OF DEHYDRATION OF BEETS.—The economic gain due to methods of dehydration would be very great, and the cost of sugar reduced a great deal, if these factories could work from the beginning to the end of the year. The advocates of dehydration claim that the adoption of this process in the case of sugar beets would bring about an ideal state of affairs. Certainly it would be possible to convey the beets long distances at a little cost on account of their small bulk, and it would also be possible to keep them without risk of deterioration until such time as it was most convenient to use them. The new scheme provides for the establishment of dehydrating plants at points near refineries, anywhere near railroads in a zone of four hundred miles therefrom.

The beets received from the farmers of the neighborhood at the dehydrating plants could be cut into small slices, *cossettes*, and at once dehydrated in this form, which is suitable for refining later. One short ton of beets is reduced in weight to 500 pounds by the process. According to R. G. Skerrett, referred to previously, the percentage loss of cossettes, measured by dry substance polarization, was only 1.66 after 730 days, and curiously enough there was a decrease of nearly 50 per cent of the original moisture. Furthermore, on account of the relatively low temperature employed, enzymic action was not impeded by dehydration, and sugar production continued for a time. Hence, dehydration of the cossettes by the most recent process actually promotes this conversion of normal sugar of the beets and reduces the cost of running the refinery and of transportation. If this novel process of dehydration exercises such an effect upon beets, there is no need to expatiate on its self-evident value.

Carrots, Parsnips, Salsify, Turnips.—Of the other so-called succulent root crops used as food, carrots, parsnips, salsify, turnips and onions are the most common. Carrots are dehydrated on a large scale and resemble fresh carrots in composition.

Dehydrated Foods Used in the Army.—In feeding the soldiers of the Allied Forces it was naturally a stupendous task to keep them supplied with wholesome and nourishing food. Well-balanced rations are essential to the maintenance of good health, and especially to men engaged in the arduous and devitalizing duties of trench warfare. In order to have a well-balanced diet a sufficient quantity of vegetables is needed; but in view of the difficulties of transportation across the Atlantic, the tonnage of this enormous amount of vegetable foodstuff had to be kept

FIG. 1.—THE VEGETABLES AT THE RIGHT, WHEN DRIED, WILL HAVE ONLY THE BULK OF THE SMALL PILE AT THE LEFT. (Courtesy of the Scientific American.)

FIG. 2.—THE BUCKET AND MILK BOTTLES CONTAIN THE WATER EXTRACTED FROM THIS BOX OF VEGETABLES. (Courtesy of the Scientific American.)

as low as possible, while at the same time furnishing the field kitchens with adequate stores. It was entirely beyond the scope of human endeavor, in fact, for the warring governments to ship whole cargoes of fresh vegetables in cold storage and later to transfer and convey them many hundreds of miles to the firing lines. For a long time canned vegetables were in great demand, indeed vegetable food was shipped

FIG. 3.—THIS BARREL OF DEHYDRATED VEGETABLES REPRESENTS THIRTY BARRELS OF GREEN VEGETABLES. It is sufficient to make soup for 6,000 men. (Courtesy of the Scientific American.)

mainly in this form. The French were the first to recognize the possibilities of dehydrated vegetables as an economical measure, and from this country and Canada have imported tremendous quantities of vegetables treated by this process. Celery, cabbage and carrots are largely grown in Monroe and Wayne counties, New York, where there are a large number of evaporators. Accordingly this part of New York State was drawn upon for supplies of these dehydrated vegetables. At the

time of writing the French Government contracts with a produce company of Belleville, Ontario, to furnish its War Department with all the dehydrated vegetables it can supply. The vegetables desired are celery, cabbage, carrots, onions, potatoes and turnips. These crops when dehydrated are mixed after a certain formula and placed in fifteen-pound cans, which are sealed and shipped to the French Army, where they are used for making stews for the soldiers.

Celery.—Celery for dehydrating purposes may be in almost any condition, as long as it is free from disease. Any variety may be used, but the unblanched green winter kind is preferred, as it retains its flavor and color best. The celery is packed in the rough or is conveyed loose to the evaporator, where it is weighed and stacked ready for further preparation and treatment. After the roots and dead leaves have been removed, the celery is placed in the washing vat, thoroughly cleansed, and is then carried to the cutting machine, whence the shredded celery drops into a box through which runs a continuous belt elevator. In this manner the shredded material is taken to the second floor, where it is caught in large baskets and conveyed to the drying bins.

METHOD OF DEHYDRATION.—The kiln method is employed here which is fully described in *Farmers' Bulletin* No. 291. Before placing the shredded celery in the drying bin, the kilns are heated to a temperature of 160° to 180° F. After the process has been completed the celery is shoveled from the bin and placed in bags for shipment.

Cabbage, Onions, etc.—The processes involved in the dehydration of cabbage are similar to those used for celery, except that the cabbage is not cleaned before shredding. The method used in drying onions is very like the method just described. The preparation of the product before shredding, however, is different. The tops and remains of roots are removed by hand and the onion is peeled by machinery. It is shredded before being elevated to the drying bins. The relative weights of green vegetables and those which have undergone the kiln evaporator process are as follows:

1 ton of green celery	150 pounds when dried
1 ton of green cabbage ...	150 to 175 pounds when dried
1 ton of green carrots	200 pounds when dried
1 bushel of onions	5 pounds when dried

Under the contract with the French Government the finished product is allowed to contain, at the maximum, 15 per cent of moisture. This requires a drying period of from twelve to fourteen hours, according to

the degree of heat produced by the kilns. The cost of treating the vegetables by the above process is as follows:

Green celery.........	$10 per ton
Cabbage.............	$8 per ton
Carrots..............	$10 per ton
Onions..............	10 cents per bushel

ADVANTAGES OF THE KILN METHOD FOR THESE VEGETABLES.—The kiln process has been in vogue the longest and is at the present time most used in this country. The use of circulating heated air at a comparatively low temperature for dehydrating vegetables is theoretically scientific and practically is superior to methods which rely upon heat alone, or mainly, as a means of dehydration. Turnips, parsnips and all other vegetables can be dehydrated, and the description of the procedure followed in one case will apply to all. Fresh carrots contain: refuse, 20.0 per cent; water, 88.2 per cent; protein, 1.1 per cent; fat, .4 per cent; sugar, starch, etc., 8.2 per cent; crude fiber, 1.1 per cent and ash, 1.0 per cent. The fuel value per pound is 210 calories. Carrots dried by the kiln process contain: water, 3.5 per cent; protein, 7.7 per cent; fat, .6 per cent; sugar, starch, etc., crude fiber, 83.3 per cent; and ash, 4.9 per cent. Fuel value per pound, 1,790 calories.

Beans.—It is often said, and indeed the view is widely circulated, that dried legumes are the rational and the best substitutes for meat. This is true to a large extent, as the dried legume is very rich in protein and in energy-giving constituents. However, drawbacks exist in certain legumes, principally in beans, which somewhat detract from their food value. In the first place, in preparing beans for the table by the usual methods, they become less concentrated, whereas the cooking of meat renders it more concentrated. In the one case water has been added; in the other water has been removed by the roasting or broiling. Dried beans are also liable to cause flatulence, due to the slow rate at which they are digested and, perhaps, to their sulphur content. Still, it cannot be denied that dried beans and lentils are wholesome, valuable and nutritious foods which may be prepared in many ways as the staple diet, and which are, all in all, the most satisfactory substitutes for meat.

COMPOSITION OF FRESH AND DRIED BEANS.—The following table, taken from *Farmers' Bulletin* 121—315 of the U. S. Department of Agriculture, shows the composition of fresh and dried legumes, compared with that of some other foods:

COMPOSITION AND FUEL VALUE OF FRESH AND DRIED LEGUMES

Material	Water	Protein	Fat	Carbohydrate	Ash	Fuel value per pound
	Per cent	Per cent	Per cent	Per cent	Per cent	Calories
Fresh legumes:						
String beans	89.2	2.3	.3	7.4	.8	195
" peas	81.8	3.4	.4	13.7	.7	335
Shelled kidney beans	58.9	9.4	.6	29.1	2.0	740
" lima beans	68.5	7.1	.7	22.0	1.7	570
" peas	74.6	7.0	.5	16.9	1.0	465
" cowpeas	65.9	9.4	.6	22.7	1.4	620
Canned string beans	93.7	1.1	.1	3.8	1.3	95
" lima beans	79.5	4.0	.3	14.6	1.6	360
" kidney beans	72.7	7.0	.2	18.5	1.6	480
" peas	85.3	3.6	.2	9.8	1.1	255
Dried legumes:						
Lima beans	10.4	18.1	1.5	65.9	4.1	1,625
Navy beans	12.6	22.5	1.8	59.6	3.5	1,605
Lentils	8.4	25.7	1.0	59.2	5.7	1,620
Peas	9.5	24.6	1.0	62.0	2.9	1,655
Cowpeas	13.0	21.4	1.4	60.8	3.4	1,590
Soy beans	10.8	34.0	16.8	33.7	4.7	1,970
Chick peas	14.8	12.4	6.7	63.3	2.8	1,690

As the great majority of these legumes are lacking in fat, it is a rational and natural proceeding to add salt pork to the baked beans and bacon to cowpeas.

It may be estimated that a pint of these dried legumes and a half pound of pork have a protein content exceeding a pound and a half of uncooked meat of average composition. Moreover, since this combination is rich in starch as well as in fat and protein, it may serve as a substitute for potato and meat.

LIMA BEANS.—Lima beans possess great fuel value. They are, however, not sufficiently appreciated as a table food because it is not generally known that they can be used in a dried state in practically the same manner as are the common beans. In reality they are richer and more delicate in flavor than the common beans.

SOY BEAN.—In far Eastern countries, where the supply of animals suitable for food is small and where a large proportion of the inhabitants are interdicted by religion and caste from killing or eating animals, recourse has been had to the vegetable kingdom to make up this lack of animal food. Legumes are the vegetables used, the soy bean in particu-

lar. Although somewhat of a digression, it will not be out of place to state in this connection that the soy bean is more important than rice as food for the inhabitants of Asia. The idea is popular that the people of India and China subsist almost wholly upon rice, whereas the truth is that, while enormous quantities of rice are consumed in these countries, the soy bean supplies the protein element essential to the conservation of health.

The soy bean is employed by these peoples in a variety of ways. The nitrogenous material and a considerable amount of the fat of the beans are separated and made into a number of special articles of diet, as bean cheese or bean curd, and soy, a thick brown sauçe used by millions of people as a flavoring material and condiment. By this means the necessary nitrogenous element and flavor are added to the otherwise tasteless rice, vegetables and other foods which form their diet.

SOY BEAN FLOUR.—A soy bean flour has been made which is said by Friedenwald and Ruhräh(12) to be most useful. It has the following composition:

Constituent	Per Cent
Protein	44.64
Fat	19.43
Mineral matter	4.20
Moisture	5.26
Crude fiber	2.35
Cane sugar	9.34
Non-nitrogenous extract	14.78
Starch	none
Reducing sugars	none
Polarization normal weight due to optically active substance other than cane sugar included in protein and non-nitrogenous extract	7.80

The percentage of protein in this flour is almost one-third greater than the percentage of protein in the whole beans. This is caused by removing the coarse fibrous hulls which contain little protein. The composition of this flour may be compared with round of beef, medium, which contains: protein, 19.0 per cent; fat, 12.8 per cent; and moisture, 60.7 per cent. Each ounce of this soy gruel flour yields about 13 grams of protein and 120 calories. It can be used as a gruel, in broths and in making biscuits.

COOKING OF BEANS.—As W. S. Hall(13) has pointed out, dried legumes require very thorough cooking, considerably more than other foods. This prolonged cooking is necessary because the nutrients, en-

closed within the walls of the plant cells, are inaccessible to the digestive juices until the cell walls have been broken down by cooking and mastication. The grinding of dried legumes into meal greatly facilitates the cooking and the mastication, and in consequence the digestibility. Owing also to the fact that dried legumes, such as navy beans and dried peas, are somewhat difficult of digestion, unless made into purées, they are less well adapted for general use in the dietaries of people of sedentary occupation than for those who are engaged in active out-of-door pursuits.

FOOD VALUE OF BEANS.—The high nutritive value of dried beans, cowpeas and other legumes, due to their protein content, renders this class of food very useful as meat substitutes. Comparing the nutritive value of dried legumes and meat, it is found that *two-thirds of a pint of dried beans, cowpeas or lentils is equal to one pound of beef* of average composition.

Corn.—In earlier times corn was dried or evaporated for domestic use by most housewives in rural districts, and at the present time sweet corn in the milky stage of its development is frequently preserved by means of dehydration. Sweet corn is a satisfactory vegetable to dehydrate. It retains its flavor and sugar content to a remarkable degree.

RELATION OF SPOILED CORN TO PELLAGRA.—One of the chief theories as to the causation of *pellagra* is that it is due to the eating of spoiled corn, the staple diet of the inhabitants of those countries or districts in which the disease is most prevalent. In Italy, this belief, inspired and fostered by the views of Lombroso, has been responsible for prophylactic measures directed mainly against the use of damaged corn as an article of food. Dehydrating or desiccating plants have been established for the artificial drying of corn there to prevent waste. These desiccators are of two types, fixed and portable. At present there are a large number of public plants for dehydrating corn throughout Italy.

Use of Vegetable Flours.—In a previous part of this chapter reference has been made to "economy loaves." These are made partially or wholly from a flour less expensive in these days and more easily obtainable than wheat flour. The advantages of dried bananas among the fruit products and dehydrated potatoes among the vegetable products were discussed. Other flours made from fruits and vegetables—from dried chestnuts, the soy bean, the white bean and several other varieties of bean, cottonseed, cassava and peas—offer promise of furnishing the public with a cheap and nutritious bread. The soy bean and cottonseed flours when mixed with wheat flours in proper proportions, about 25 per cent, furnish a bread with about twice the amount of protein that ordinary

wheat bread contains. Stress should be laid upon the fact that wheat flour is not essential for the production of a good, nutritious and wholesome bread. A bread made of some other cereal, of corn, for example, will in almost all respects equal bread made from wheat flour. The addition of a vegetable or fruit to wheat flour, as the dried potato, bean, banana or chestnut, will not detract from the food value and will be more economical and quite as satisfactory as a bread made from wheat flour, cornmeal or rye flour alone.

Yeast.—A food material which comes under the head of vegetable products and which when dehydrated is now somewhat largely used as food for man and beast, is yeast. The main object in drying yeast is to utilize to the fullest extent its excellent food properties and to make it available for transportation over long distances. Up to the present time the constructors of yeast dehydrators have relied chiefly upon the experience gained in the construction of potato driers. The working principle of all the yeast driers on the market is practically the same. The moist yeast passes over steam-heated cylinders, where it is freed from most of its water in the fraction of a minute. Scientific researches have shown that dehydrated yeast is one of the richest of concentrated foods, and attention may be called to the fact that the food value of such yeast cannot be estimated in the same way as the food value of other foods, such as potatoes, wheat or corn. It is considerably higher on account of special dietetic properties. *Yeast has a very high vitamine content.*

Dry yeast has given good results when fed to domestic animals. It is stated that when milch cows are fed upon it the yield of butter is increased.

According to J. C. Smith(14), it has been demonstrated that a great many inexpensive and nutritive dishes can be prepared from debittered, dried yeast, and physiological experiments have shown that this food yeast is wholesome and very easily digested. Experiments have shown that one pound of dried yeast is equal in food value to 3.3 pounds of average fat beef, and furthermore its advocates state that it is not only valuable as an article of food, but is indicated as a means of invigorating devitalized individuals.

SUMMARY

The domestic dehydration of vegetables and fruits is becoming a quite common practice. The best and most efficient form of a home dehydrator is that which withdraws the water by the agency of dry steam, and not by hot air.

Success of Dehydration.—Practically all vegetables and fruits can be successfully dehydrated commercially by employing heated air at a comparatively low temperature for a rather short period of time. In this process the air currents should thoroughly penetrate the vegetables and fruits subjected to the treatment. To a lesser extent the above remarks apply to the dehydration of animal foods. Meat does not lend itself particularly well to this mode of preservation, but the desiccation of milk with retention of its solubility, nutritive properties and vitamine elements intact, if not an accomplished fact, is in a fair way of becoming so ere long. As Mendel has said, "If the best dried milk of the future shall be shown to retain even the more subtle physiological properties, such as its antiscorbutic potency, it will represent good achievement." A dried milk does not deteriorate and is sterile, most important factors in the conservation of the public health.

With the possible exception of milk, the dehydration of animal foods has not been as successful as in the case of vegetables and fruits. The dehydration of fruit is quite satisfactory, so also is the dehydration of vegetables. The flavor and taste of certain fruits are more apt to be altered or attenuated than that of vegetables.

Economic Advantages.—From the economic aspect, dehydration of foodstuffs seems destined to revolutionize the entire food situation. The immense waste of vegetables and fruits which is now universal should be prevented in the future. The farmer or producer of food products will be independent of the local markets. His produce will be dehydrated on the most approved system at a nearby plant. Such produce, on account of its keeping properties, comparative lightness and small bulk, can be delivered at a low cost in this country or abroad. Vegetables weighing a pound can be transported thousands of miles and made into soup or stew sufficient for fifty or sixty hearty adults.

The value of dehydration methods of preserving food to exploring parties, to workmen engaged in operations in out-of-the-way parts of the world and so on, is so patent as to require neither emphasis nor elaboration. Enough has been said on the subject of dehydration to show that when carried out in a strictly scientific manner, it is a long step in the direction of the ideal system of economizing the food supply of a nation.

In this chapter a certain amount of repetition may be observed. This has been done intentionally in order to emphasize the need for economy of food products and to draw attention to dehydration as an important factor in the achievement of this object.

The war has had some redeeming features, some advantages to

counterbalance, in a slight degree, the dreadful loss of human life and the reversion to barbarism which have blackened its course. It has aroused the race from the slough of self-indulgence and apathy with which many years of peace and prosperity had imbued its members, and has taught them with the whip of adversity that self-restraint and endurance were still to be regarded as *high* among the cardinal virtues. Perhaps no calamity brought about by the war has served better to teach this lesson than the lack of food. Shortage of the food supply quickly brings home to all sorts and conditions of men and women the truth that food is after all one of the essentials of life and that without a sufficient provision of food, life is hardly worth living. Consequently, one of the effects of the war has been to quicken man's brain to devise means for producing more food, to economize that which has been produced, to search out and cultivate foods which can be more easily and cheaply produced, and to be satisfied with simpler and more wholesome food products. The fear of famine has spurred him on in this endeavor. Therefore it may be said with truth that the war will be responsible for at least a partial, if not the complete, solution of the food problem, and that the development of such measures as dehydration of foodstuffs is an indirect consequence of the war.

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CHAPTER III

SCIENTIFIC COOKERY

H. S. Grindley, B.S., Sc.D.

We may live without poetry, music and books, but civilized man cannot live without cooks. (Owen Meredith.)

History of Cooking.
Principles of Scientific Cooking: Changes Produced by Cooking; Evil Effects of Poor Cookery.
Varieties of Cookery: Meat—Boiling, Stewing, Frying, Baking, Roasting, Broiling, Braising, Steaming; Losses in Cooking Meat; Cooking of Fish; Cooking of Vegetable Foods.
Food Concentration: Desiccation; Concentrated Proteins; Dried Vegetables; Desiccated Milk; Desiccated Eggs; Meat.

HISTORY OF COOKING

Cooking as an art has been developed from the crude methods used by primitive peoples from almost the beginning of time. The early Egyptians, it is said, had professional bakers. We read of their roasting and boiling the flesh of oxen. The Greeks attributed the discovery of bread-making to the god Pan, but bread was in use among the Chaldeans and Egyptians before the Greek gods had their inception. Ching-Nong, 1998 B.C., is reputed to have been the first who taught men the science of making bread from wheat. So we see that bread is a very ancient food, its origin being lost in the mists of antiquity. In the days of the patriarch Abraham, his wife, Sarah, made cakes which were thought to be a fit offering for angels. Prior to the bondage of the Israelites in Egypt, baking had become a highly perfected art. The Egyptians used many varieties of flour and made cakes of various kinds and shapes. According to sacred history, one of the most important servants in the service of Pharaoh, during Joseph's régime, was a professional baker.

There appears to have been considerable difference as to the manner in which good eating was appreciated by the early Greeks. After the Homeric age of simplicity, in which roast and boiled meats seem to have sufficed the kingly table, a diversity of preparation was attained in cooking, and a certain epicureanism was displayed in the quality, seasoning and method of dressing food. The Greeks boiled and roasted the flesh of sheep, pigs, lambs and goats. They cooked poultry, small birds, game and sausage. Fish was the principal article of food with all classes of Greeks, but with the wealthier classes much skill and delicacy were attained in the stuffing and cooking of fish. The Romans(1) were not far behind their Greek brothers in the culinary art; by degrees, however, a taste for better eating crept in; and after the Asiatic conquest, luxury in eating was introduced by Lucullus. There is plenty of evidence that primitive peoples of all races, savage, semi-savage and civilized, barbecued their meats over heaps of live coals, or roasted over the coals pieces of flesh cut or torn from big game. Small animals were sometimes roasted whole over the coals and sometimes they were incased in mud and then baked in hot ashes.

Prehistoric man may have lived wholly on raw food, berries, fruits, shellfish, etc. (*see* Chapter I, Volume I, The Evolution of Man's Diet), but this diet is not suited for most races of man today, although the northern Eskimo still prefers to eat his meat raw and frozen. While it is possible for man to live upon raw food for a considerable length of time, it is apparently designed by nature that a large portion of his food should be cooked, for there are no savage races who do not practice the art of cooking, in however elementary a fashion, and progress in the scale of development and civilization is uniformly accompanied by advance in the art of cooking.

Of ancient British cookery very little is known; no doubt it was crude. We find but little mentioned of the art of cooking in the Saxon Chronicles. The Danes and Germans appear to have been great drinkers and to have paid little attention to the preparation of foods. The Normans were more particular in these matters; some offices among them were held by right of the kitchen. We do know, however, that the mortar was extensively used by the Anglo-Saxons and that oil and lard were used instead of butter.

The French were the first to introduce art into the process of preparing foods, but it was not until the introduction of Italian taste by the princesses of the House of Medici that cooking became an art. The ancient use of oil was modified through the discovery made by the French of dressing meat in its own gravy, and at the present day it is universally

admitted that the French cook is a true gastronomic artist, and it is for his perfection in this art that all the hotels of any importance in this country employ a Frenchman to fill the post of *chef de cuisine.* The estimation in which his services are appreciated may be understood by the large salary attached to this office in fashionable hotels and club houses. A visit to the kitchen of one of these establishments shows what a highly important post he fills. Such a person should know not only how things are to be done, but he should have the organizing ability to arrange and direct the work of the numerous assistants.

During the past decade the art of cooking as a branch of woman's education has been given considerable attention in this country. Domestic science classes, in connection with universities and other institutions of learning for young women, have been established in New York, Boston, Philadelphia and other places.

PRINCIPLES OF SCIENTIFIC COOKING

It is an error to suppose that cooking increases the digestibility of all food; this is not the case with animal foods, as cooking diminishes rather than increases their digestibility. Proper cooking increases the digestibility of vegetable foods by breaking down their cellulose coverings, thereby allowing rupture of the starch grains, which aids the free admixture of the digestive juices and hastens the chemical process of digestion(1).

Generally speaking, all foods except fruits having organized structure require cooking. It is well known that the majority of fruits, and some vegetables, are eaten raw by preference, without interfering with the appetite; but food from the animal kingdom, as a rule, requires thorough cooking. Raw animal food has been eaten by man, but it becomes wearisome; an exclusive animal diet soon excites disgust. Milk, eggs, oysters and clams are an exception.

While the physician need not be a cook, he should understand the general methods of preparing foods, and should know the ingredients of compound dishes just as thoroughly as he knows the meaning of Galenical terms and the ingredients of tinctures, compound powders, pills, etc. If he is ignorant of the composition and proper preparation of foods, he cannot intelligently supervise the diet of his patients. He should study dietetics exactly as he studies the *pharmacopœia* or a work dealing with pharmacognosy or *materia medica,* not that he need master the art either of cooking or pharmacy, but that he may have an intelligent, general comprehension of both subjects.

The essential part of all cooking processes is the scientific application of heat, and it is important to have a clear understanding of the effects of heat upon the various chemical constituents of food. For instance, heat coagulates the protein of foods; still it would be erroneous to suppose that a boiling temperature is necessary to bring about this change, since proteins, both animal and vegetable, are coagulated if their temperature is raised to 170° F. Ignorance of this fact is a fertile source of error in cooking. When the temperature of a piece of meat is raised much above this point, the protein is hardened and shrunken, and the digestibility of the meat is proportionally lessened.

The vegetable foods are more readily affected by heat than animal foods, and of the carbohydrate foods, starch is most affected. Dry heat applied to raw starch converts a portion of it into soluble form, and ultimately into dextrin. This is accomplished, to a slight extent, in the outer crust of bread and in the preparation of toast. Moist heat applied to starchy foods causes the starch molecules to swell, bursting the cellulose coverings, when the foods are said to be gelatinized. This occurs below the boiling point of water, as shown by the following table giving the gelatinization points of different kinds of starch:

GELATINIZATION POINTS OF VARIOUS STARCHES

Oats	185° F.
Barley	176° F.
Rye	176° F.
Wheat	176° F.
Rice	176° F.
Maize	167° F.
Potato	149° F.

From the above table it is observed that the gelatinization of starches can be effected at comparatively low temperatures. In the chapter on Sugars, Spices and Condiments (Volume I, Chapter XVII), the effect of heat on sugar has been described, and therefore it need only be mentioned here that the partial conversion of sugar into caramel is one of the means by which flavor is developed in the meals by cooking.

Fats are less affected by heat than proteins and carbohydrates. When subjected to high temperatures, however, a portion at least of the fat may possibly undergo a partial decomposition with the liberation of free fatty acid(2). This explains why hot fat is much more apt to prove irritating to the stomach than cold fat, for it is quite probable that the fatty acid may reunite with glycerin to form neutral fat on cooling. Fat which has

been heated and allowed to cool is often found to have become granular in appearance. This change is no doubt brought about by driving off water, and it tends to render the fat more brittle, and consequently easier to digest. This change is apparent to anyone who has watched the "dripping" or "rendering" of lard, or the process of drying bacon.

The great difference between the French, English or American cooking consists in the fact that the French cook their meat much longer. They are therefore enabled to make a variety of dishes by altering or annihilating the original taste of the meat and making it a vehicle for foreign flavors. The variety, daintiness and grace of form which dishes thus acquire are very admirable. The French cook throws nothing away. Instead of going to the butcher for meat for stock, as the American cook does, he uses the trimmings for stock and the skimmings of his boiled meats in many combinations where the American uses butter or lard; like every skilled workman, he produces great results from small means.

Changes Produced by Cooking.—Efforts are being made to teach cooking in the public schools, and in this respect much good work is being accomplished. For any shortcomings in cooking, however, the taste of the American is in some measure accountable. The results of cooking food are as follows:

(*a*) Cooking develops certain savory flavors in food—more particularly in meat—which are agreeable to the palate, and thereby enables man to secure a variety in taste which is often important as a stimulus to the appetite.

(*b*) Cooking alters the consistency of food generally, making it softer. Eggs are the exception; they become harder when boiled. Cooking also renders meat more coagulated and solid, more tender and friable, and easier to masticate. This allows of more free mixing of the various digestive fluids with the food.

(*c*) Cooking produces chemical changes in food which favor the action of the digestive enzymes. This is particularly true of some forms of starch and many varieties of meats.

(*d*) Cooking not only sterilizes the food but destroys many varieties of parasites and germs which may be contained in the food and which may be highly poisonous. It has been found that no animal parasite in meat is capable of withstanding a temperature of 70° C. All ordinary processes of cooking will render meat free from this source of infection.

(*e*) The ingestion of very hot food is sometimes advised to favor the digestive processes, although the importance of this consideration is apt to be exaggerated.

(*f*) Cooking improves the appearance of many foods, and often produces a delightful aroma which makes the morsel more appetizing.

Evil Effects of Poor Cookery.—Good, wholesome and proper food materials are often rendered valueless from poor cookery. The unwholesomeness of food is quite as often due to bad cookery as to improper selection of material. When scientifically performed, cooking changes each of the food nutrients, with the exception of fats, in much the same manner as do the digestive juices, and at the same time it breaks up the food by dissolving the soluble portions so that it is more readily acted upon by the chemical processes of digestion. The evil effects of bad cookery and the improper selection of foods are too numerous to mention. No doubt their ill effects are as far reaching as the use of strong drink; indeed, one of the evils of unwholesome food is its decided tendency to create a craving for drink. For bad cookery is the forerunner of indigestion, which condition causes thirst, and thirst is apt to produce and to perpetuate drunkenness. One who has suffered from a fit of indigestion and recalls the accompanying headache and the lowness of spirits, going from dejection and ill-humor to extreme melancholy with all the mental faculties dazed and the normal feelings more or less blunted, will hardly wonder that such a condition may become chronic, which is often the case from the continued ingestion of improperly prepared foods. It is not surprising, then, that the victim of such circumstances is easily led to resort to stimulants to drown depression and enliven spirits.

VARIETIES OF COOKERY

The processes of cooking in common use are as follows:

(*a*) Boiling	(*e*) Roasting
(*b*) Stewing	(*f*) Broiling
(*c*) Frying	(*g*) Braising
(*d*) Baking	(*h*) Steaming

There can be no question that there is decided advantage in varying the different methods of cooking, as well as flavoring the food, from time to time. Monotony of diet and the continued sameness of flavors are not stimulating to the digestive organs or appealing to the appetite; and when conditions are such that a variety of food cannot be obtained, variety in their preparation can be made to replace its advantages to a great extent. Even an epicurean appreciates the effect on appetite of an occasional change of cooks, or, if he be a home person, of an occasional meal, dinner or luncheon in a friend's home or at a hotel or restaurant. It is not the

intention of the author of this work to discuss all the details of the preparation of foods for the sick, since every trained nurse should be well grounded in the art of domestic science and in invalid cookery which should form the basis of her education. We cannot hope to do more than explain the theory of the chief methods of cooking and suggest occasionally the influence of scientific cookery upon digestion. Meats which have been twice cooked are undesirable for invalids, as they are apt to be drier and less nutritious and more difficult to digest than when fresh. For this reason, when "hash," for example, is twice cooked, the meat fiber is too greatly hardened. Such preparations, by the addition of too much grease and by recooking, are not proper dishes for delicate stomachs; for a similar reason canned meats, when warmed over, are not as easily digested as fresh meats, because they have been already cooked once. Made-up dishes combining different foods which require different periods for their cooking are undesirable. Soup, for instance, needs less boiling than the vegetables added to it, which should in all cases be partially cooked alone beforehand so that they will not be underdone. The necessary heat for the different varieties of cooking is obtained from many sources: from wood, coal, gas, oil, steam, electricity, and of late from the "fireless cooker." Each one of the different methods possesses advantages for particular foods.

With these preliminary considerations, we may proceed to the study of the effects of cooking upon animal and vegetable foods, respectively.

COOKING OF MEAT

Boiling.—The primitive method of boiling water originally consisted in heating the water in a hollow dug-out in the ground by plunging in red-hot stones taken out of the fire. Later, as pottery-making and metal-working became an art, cooking utensils were employed. The use of the term "boiling" (212° F.) in connection with the cooking of meat is rather unfortunate, for the operation thus designed, if properly carried out, should involve hardly any boiling. The temperature should be just sufficient to change the coloring matter of the blood, soften the fiber and dissolve the connective tissue, which can be successfully accomplished by water far below its normal boiling point. Boiling meat in its strict sense over-coagulates the proteins, dissolves the mineral matter, and lowers the caloric value of the food. This is best shown in a hard-boiled egg, in comparison with one cooked below the boiling point. In the former the albumin is rendered hard and indigestible, and in the latter the albumin is soft and creamy and is even more easily digested than when raw. While

the effect of over-boiling meats is not so apparent as in the case of eggs, the end results are precisely the same. In the cooking of meat, however, some boiling as a preliminary process of the operation is necessary, since the juices of meat are rich in albumin; it is necessary to cover the meat with boiling, unsalted water and boil it rapidly for five minutes to coagulate the albumin on the surface and inclose the meat in a waterproof casing. This will prevent the escape of the meat juices from the interior of the cut. The next step is to place the pot over a moderate fire where the temperature will be maintained at 180° to 200° F., twenty minutes being allowed for each pound of meat. If the heat is not carried to this point, the interior of the joint or piece of meat is not perfectly cooked, its albumin is not sufficiently coagulated, and the cut will have a raw appearance. If, on the other hand, the actual boiling point is long continued, the albumin will be firmly coagulated and the meat will be tough and stringy. This error in boiling meat is often perpetrated by incompetent cooks.

It is a scientific fact, unappreciated by many persons, that when water has once reached the boiling point, its temperature cannot be further elevated; consequently, however hot the fire, or however prolonged the cooking, the temperature of the food suspended in the boiling water cannot be increased above that of the boiling water itself; and the fact remains that the temperature of the interior of large masses of food—such as a cut of meat or large potatoes—is by no means as great as that of the surrounding water. For this reason, it is a mistake to pile on more fuel when water has once reached the boiling point, as it will have no further effect than that of accelerating the rate of ebullition, without actually raising the temperature of the water or any food immersed in it.

The concentration of broth or bouillon is dependent mainly upon the method used in boiling the meat from which it is made. If the meat is subjected to continuous boiling for an hour or more, the connective tissue is gradually transformed into gelatin which in part becomes dissolved in the water. A little of the fat, melted by the heat of the water and not being able to mix with the latter, floats as scum on the surface. In addition, a small quantity of the meat juice exudes into the surrounding liquid, which at this stage is known as broth or bouillon. In order to make a very concentrated and nutritious broth, the meat is cut in fine pieces, put into cold water and left for a time. It is then placed on the stove and slowly warmed, although it must not be allowed to reach the boiling point. If the temperature does not pass beyond 160° F., the meat juices will be dissolved in the water. As the water is not hot enough to coagulate the albumin of the meat, an increasing quantity of the con-

stituents of the muscle fibers passes out to become dissolved in the broth. Such preparation gives to the broth the natural flavor of the meat. The ordinary meat extracts are manufactured by allowing finely minced meat to stand in cold water for a time, after which the water is evaporated from the ingredients. If the purpose of cooking is to leave as great a quantity as possible of the nutritive elements in the meat itself, a somewhat different process is employed. The meat is quickly plunged into boiling water and left there for five minutes. By this method the surface of the meat is coagulated sufficiently to form an effective barrier to the passage of the nutritive juices from within. When the cooking is completed, the meat holds practically all of its original nutriment and is consequently most palatable. On the other hand, the broth contains a minimum quantity of the meat juices in solution and therefore possesses only slight food value.

The fact that the coagulation point of a given variety of albumin varies considerably must not be overlooked. Some albumins are coagulated below 90° F. while others require a heat of 165° F.; and since many varieties of albumin occur in different kinds of animal food, it will be found that they are not all equally well cooked at the same temperature. Parkes is the authority for the statement that ammonium sulphite is liberated by continued boiling and an acid resembling acetic acid is also produced. Meat when plunged into boiling water has its external layers immediately solidified. Some of the water which they contain is squeezed out into the adjacent fluid and an actual loss of weight in meat occurs, ranging sometimes as high as 30 per cent. Williams is authority for the statement that, when salt is added to water in boiling fish or meat, it produces a threefold action: (*a*) It directly acts on superficial albumin with a coagulating effect; (*b*) it slightly raises the boiling point of water; (*c*) by increasing the density of the water, the exosmosis of the juices is less active, and hence the flavor is better retained. When salt meat is to be cooked, if steeped too long in boiling water, its nutritive properties are impaired, and the muscular fiber becomes hard and the meat loses its inviting taste and becomes tough. In the preparation of such a cut, it would be well first to boil the meat less completely, and finish the cooking by some other method, either frying, roasting or broiling.

Stewing.—Stewing, or preparation *en casserole*, is in many respects an ideal method of cooking meat. It differs from boiling in that the juices of the meat are dissolved in the heated water, whereas in boiling, the juices are prevented from passing out into the water by the coagulation of the albumin on the outer surface of the cut. If properly performed, stew-

ing coagulates without over-hardening the proteins, while owing to the fact that the juice is eaten together with the meat, none of the flavoring ingredients are lost. The proper temperature for stewing ranges between 135° F. to 180° F. The prolonged action of heat and moisture converts most of the connective tissue into gelatin, so that the fibers readily fall apart and the meat becomes very tender. Here again, the secret of success is in avoiding too high temperature. It is sufficient to place the pan on the side of the fire and allow it to *simmer* only, instead of to boil. The thermometer will show that the temperature of simmering and boiling water is practically the same, 212° F., the only difference being that in the former case the heat is reaching the water more rapidly and more of it is wasted. The proper temperature for scientific stewing is 180° F.

In thick stews, the juices dissolved in the water are eaten together with the cooked food; but, when it is desired to make beef tea or other kinds of soup, an aqueous solution only is used. It is obvious to the reader that the more the food is subdivided the greater will be the surface exposed to the solvent action of the water, and hence the reason of mincing meat thoroughly when it is to be used for the preparation of beef tea. If such minced meat has been soaked for a long time in cold water, a part of its albuminous substances and some of the extractive materials will already be in solution. But the meat which is left will be tasteless, odorless and unpalatable; in fact, animals fed upon such meat soon deteriorate in strength.

The perfection of a meat stew largely depends upon the thorough coagulation of the outside juices and the slow process by which it is finished, while, as before stated, the temperature should never exceed 180° F. Such flavorings as bay-leaf, onion and celery, pepper and salt, may be added, but the saucepan should be closely covered so as to retain all the flavors. Stewing is a very economical method of cooking; there is no waste; all escaped juices are held in the solution; all the nourishment is secured, and if the dish is well cooked and not too greasy, the meat is tender and readily digested. The difference between stewing and other processes of cooking is graphically explained by Williams, who says: "Instead of the meat itself surrounding and enveloping the juices, as it should when boiled, roasted, grilled or fried, we demand in a stew that the meat juices shall surround or envelop the meat."

Frying.—Frying is a process of cooking by immersion in hot fat at a temperature of from 350° to 380° F., and not by radiation, as in the case of broiling or roasting. Since this method of cooking is often grossly misunderstood, it requires some special description; as explained by Williams, "fat does not necessarily boil, for the food, as well as the fatty

material itself, may contain a large percentage of water which, by being suddenly vaporized, produces the familiar spluttering which accompanies the process of frying."

Fats, when heated to 400° to 500° F. or above, decompose, yielding fatty acids and other products, some of which are volatile. But fats and oils used in cooking do not require a heat of above 400° F., which will cause a very disagreeable odor with much smoke, leaving a non-volatile carbon residue.

If a temperature not exceeding 380° F. is maintained, the fat does not smoke or decompose. It is chiefly on account of overheating that fried foods are often unsightly and indigestible. It is difficult to regulate the temperature without the aid of a thermometer; but the following test may serve to indicate that the proper temperature is nearly reached—a crumb of bread dropped into a pan of hot fat will turn brown in ten seconds if the temperature has reached 340° F.

Butter is not a suitable medium for frying, because it rapidly decomposes at too low a temperature. Olive oil or cottonseed oil is far preferable. A mixture of oil and suet is very good; but the best medium for frying purposes is a mixture of lard and suet. The frying pan should be sufficiently deep to permit the complete submersion of the article to be cooked. The temperature of the fat will at once cause the formation on the surface of the article being cooked of a complete covering through which neither grease can enter nor the juice escape. Without this impermeable covering, the outside of the fried food will be greasy and the inside flavored with the frying materials, while if proper precautions are observed, the fried article will be as free from fat as if it had been cooked in water. With a suitable pan, and the fat at the proper temperature, everything is ready for "frying," and the article should be plunged into the fat and left for two or three minutes. The spluttering which follows is due to the sudden conversion of the moisture on the surface of the food into steam; when this has ceased, the cooking is complete and the food should be instantly removed and allowed to drain on paper, to remove all traces of fat. It will be observed that the process is entirely different from the so-called frying usually practiced in well-regulated homes, in which a little fat is employed merely to prevent the food from adhering to the frying pan—an abbreviated form of roasting really being performed. Frying, after all, is less perfectly understood by the ordinary cook than almost any other process of cooking meat, and, as usually carried out, results in abominably prepared and unwholesome food. The pans are not deep enough and the food and fat are scorched and rendered unpalatable and quite indigestible.

Baking.—Baking is a process of cooking meat in the dry heat of an oven. The oven of the stove generally receives its heat from the fire-box, although in large establishments it is heated by steam under pressure. No matter how great the surrounding heat, a thermometer placed in the center of the cut or joint will scarcely register 200° F., the meat being really cooked in its own juice at a gentle heat.

This method of cooking meat—in a confined space—prevents the volatile products from escaping, as in roasting, and in consequence, the meat has a somewhat stronger and less delicate flavor than when roasted; it is also richer, and therefore more liable to disagree with persons of dyspeptic tendencies. This process of cooking causes the cut or joint to become saturated with empyreumatic oils—unless its surface is protected by a pie crust, as in the case of "pot pie" or "chicken pie"—but even that does not add to its digestibility.

Certain mechanical and chemical changes take place during the process of baking; considerable moisture is driven off, therefore baked foods are drier when cooked than before cooking; heat and moisture present in the foods cause a rupture of the cell walls. In this way the proteins are coagulated, and possibly other changes in the texture and consistency of the foods are produced. The chemical changes brought about are as follows: Proteins are coagulated, fats are more or less broken down into simpler bodies, and carbohydrates on the surface especially are to a greater or lesser extent caramelized.

Baking with dry heat—food confined in a closed oven—may be termed a slow process of cooking, and it is interesting to learn that the advantages of slow cooking are not altogether unknown to some savage tribes. In this respect the civilized cook may learn something from their crude methods. Mr. F. T. Bullen(3) describes as follows the process of baking meat as practiced by the Kanakas of the Friendly Islands, and we doubt if any better illustration of the advantages of slow cooking can be found:

A hole is scooped in the earth, in which a wood fire is made and kept burning until a fair-sized heap of glowing charcoal remains. Pebbles are then thrown in until the live coals are covered. Whatever is to be cooked is enveloped in leaves, placed upon the pebbles, and more leaves heaped upon it. The earth is then thrown back into the cavity and well stamped down. A long time is, of course, needed for the viands to get cooked through, but so subtle is the mode, that overdoing anything is almost an impossibility. A couple of days may pass from the time of "putting down" the joint, yet when it is dug up it will be smoking hot, retaining all its juices tender as jelly but, withal, as full of flavor as it is possible for cooked meat to be. No matter how large the joint is or how tough the meat, this gentle suasion will render it succulent and tasty; and no form of civilized cookery can in the least compare with it.

The baking of bread is considered with the cooking of vegetables, in Volume I, Chapter XIII, page 365.

Roasting.—Roasting is a process of cooking meat, in which heat is conveyed by direct radiation, in a closed oven instead of through the medium of water(4). The terms broiling, grilling and roasting denote the same operation. The first two are used to designate the process when applied to steaks or smaller pieces of meat; the term "roasting" is used when a "large joint" or "rib roast" is cooked. In the process of roasting there is considerable loss, especially if the joint be a fat one, but the flavor is incomparably finer than if baked or boiled. Roasting of large joints of meat and of fowls is perhaps best done by hanging the article to be roasted on a spit which slowly revolves in front of and in close proximity to a clear and quick burning coal fire. In large restaurants this is the process generally followed.

For the proper roasting of a joint, much care is necessary to avoid excessive heat except for a period of five minutes (175° F.), in which the coagulated albumin will completely seal up and cover over the external surface of the meat; for the same reason as in boiling, the temperature should then be slightly lowered. The process of cooking meat in this manner is somewhat analogous to that of stewing; in fact, the interior portions of the meat are "stewed in its own juices" instead of water.

The outer coating prevents the evaporation of the juices of the meat which, together with the extractive materials, add flavor to the roast. Roasted meat has a decided advantage in flavor as well as nutritive value over meat which has been boiled for a long time, although the latter may be more tender and more easily digested.

The high temperature suddenly applied in roasting meat produces a firmer coagulation on the external surface of the joint than occurs in boiling—by which process more of the natural juices are retained. "If the principles of scientific roasting are carefully observed," says Williams(5), "the meat should be cooked by the action of radiant heat projected towards it from all sides while it is immersed in an atmosphere nearly saturated with its own vapor."

The proper roasting of meat or fowl cannot be accomplished without the effusion of more or less of the meat juices and the melting of a small portion of the superficial fat and of gelatin. These substances in solution form the "meat gravy," which is quite savory and very nutritious, and which a good cook advantageously uses for "basting" the roast to prevent drying, and to distribute the heat more uniformly over the surface. The process of roasting, if correctly performed, not only prevents the escape of

the natural meat flavors, but develops in it substances which are themselves of a sapid savory nature. These savory substances result from changes produced by the action of the heat on the extractives on the surface of the meat somewhat analogous to the alteration which sugar undergoes in its conversion into caramel. The action of high temperature on these substances produces a dark brown, sticky substance on the surface of the fowl, roast or joint which is familiar to everyone. This is sometimes called *osmozone* and is one of the most tasty and sapid substances known.

Meat which by accident has become "over-roasted" or burned, will present scorched or charred surfaces, due largely to the carbonizing of the fat. Before the fat has become completely burned, certain volatile fatty acids are liberated which emit a very disagreeable odor; besides, other products are developed which are of no nutritive value, but which may be positively irritating to the alimentary canal.

For the proper roasting of beef, mutton and game, according to Yeo, a temperature of 135° F. is sufficient, and the meat is "rare" and "underdone," retaining a good deal of its reddish color; but veal and poultry should be roasted at a higher temperature—from 150° to 160° F. These temperatures are slightly lower than often recommended, and are intended as the degrees to be maintained after the meat is placed in position and has had the first five minutes of excessive heat previously mentioned. It is interesting and at the same time important to remember that the smaller the cut to be roasted the hotter should be the fire. An intensely hot fire coagulates the exterior and prevents the drying up of the meat juices. This method would not, however, be applicable to large cuts, because meats are poor conductors of heat, and a large piece of meat exposed to this intense heat would become burned and changed to charcoal on the exterior long before the heat could penetrate to the interior. Hence the rule: the smaller the cut to be roasted, the higher the temperature to which it should be exposed.

Game or meat which is "high" or slightly tainted, if cooked by boiling or stewing becomes extremely repulsive and the odors from it exceedingly offensive. It disintegrates more rapidly and the elements of decomposition pass into and flavor the whole mass. Such meat may be made more or less palatable, and sometimes wholesome, by roasting, when the external layers which have commenced to decompose are thoroughly browned and thereby disinfected, though repulsive putrefactive odors will be noticed. As pointed out in the chapter on Animal Foods, "high game" is in a putrefactive stage—a condition produced by certain microörganisms or bacteria which are constantly floating in the atmosphere, in search for a convenient

place of living and breeding, and which find the juices of flesh ideal for their purposes. The period of time required for a piece of meat, game or fowl to hang, in order to obtain the proper game flavor, depends somewhat upon the season of the year, the temperature and the climatic conditions; and the boundary line between the "gamy flavor" and the stage of putrefaction is very narrow and easily passed without recognition.

The game flavor is due to the metabolic activity of the microorganisms which have settled upon the meat, and which, by a process allied to that of fermentation, produce changes in the albumin and other constituents, giving rise to certain aromatic bodies. These microörganisms of putrefaction produce an enzyme which, in coming in contact with the albuminous portions of the flesh, may so act as to produce poisonous substances known as *ptomains* and *leukomains.* Game that is "high," or meats which are tainted, though apparently well cooked, are liable to produce *ptomain* poisoning. The heat employed in the process of cooking destroys the bacteria in the meat, and it may be safely eaten while it is hot; but the heat may not have been sufficient to destroy the enzyme of such bacteria—which goes on destroying albumin, with the production of ptomains or leukomains even after cooking. It may thus happen that a portion of tainted meat is sometimes partaken of quite freely and with impunity immediately after it is cooked, but a few hours later, ptomains having then been produced by the enzymes, it becomes very poisonous. Some epicures prefer to have a leg of mutton or a piece of game hung until the process of decomposition is noticeable and the tainted odors present, but meat to be cooked by boiling must under all conditions be *absolutely* fresh.

Broiling.—Broiling or grilling is a means of quick cooking, requiring much less time than roasting or boiling, because intense heat is applied to comparatively small pieces of meat. The object in broiling is to raise the temperature of the interior of the meat quickly to 180° F., so that the moisture contained in it will not have time to evaporate. For successful broiling, therefore, it is necessary to have the meat as close as possible to the glowing coals to increase the radiation and to limit the retarding effects of air currents. It is for this reason that steaks and chops cooked in restaurants or hotels are often better than those cooked in the home, where one cannot have the specially designed grills or revolving spits which bring the meat in close contact with the radiant surface of the glowing fire.

In broiling steak, the meat should first be placed over a clear, hot fire until one side is seared; then it should be turned and the other side seared

in like manner. The steak should now be placed at a greater distance from the fire and the cooking thus continued at a lower temperature, five minutes being allowed for a steak one inch thick, if liked rare, and eight minutes if preferred well done. A steak one and a half inches thick requires from eight to ten minutes, and a steak two inches thick twenty minutes. Seasoning may be added after the steak has been cooked. A favorite seasoning for steak is *maître d'hôtel* butter (¼ cup of butter, 1 teaspoonful of salt, ½ saltspoon of pepper, 1 tablespoonful of chopped parsley and 1 tablespoonful of lemon juice). A properly broiled steak or chop is thickened in the center, but if badly grilled it is thin and dry. It should not be overlooked that the evaporation in broiling depends upon the extent of the surface of the meat, and for this reason thinly cut steaks or chops become comparatively dry and shriveled in the center.

Roasting and broiling are the most universal methods of cooking meat. The savage or hunter requires no utensils for cooking his game, but for boiling it is necessary to have vessels in which to place the food. The Polynesian cooks his meat by roasting it on a hot stone, and sprinkles it with sea water to obtain the salt. The primitive hunter incases his meat or fowl, skin and all, in damp clay and bakes it by surrounding it with hot coals. The Australian savage, the lowest type of man, does all his cooking by roasting.

Braising.—Braising is a process of cooking intermediate between boiling and baking. First the meat is partially browned and cooked in a moist heat in a vessel with a close fitting lid. Some of the so-called "roasting pans" or "braising pots" are suitable for this purpose. The meat should be placed in a pot or pan and partially covered with hot "stock" or water composed of a solution of animal and vegetable juices called "braise." Seasoning such as bay-leaf, onion, celery seed, etc., should be added and the pan closely covered. Cooking should be done in a hot oven in which the meat is exposed to a strong but not boiling temperature, 15 minutes being allowed for each pound of meat. Sherry or some spices may be added, such as cloves or mace; salt and pepper should be added when the meat is about half done. The cover of the vessel should be removed half an hour before serving and the stock reduced so that it can be served as a sauce. The amount of sauce allowed to remain should be barely sufficient to cover the meat, and in this way the surrounding broth is kept highly concentrated. Braising is an economical process of cooking; the constituents lost by the meat from evaporation and solution are absorbed almost entirely by the gravy. This process of cooking is especially valuable in cooking tough meat or any kind of meat which is too

fresh or young. It is best adapted to the so-called inferior pieces, as a leg of mutton, the upper and under round, and the fleshy part of the shoulder.

Steaming.—Steaming as a process of cooking meat is but little used and is mainly applied to cooking cereals, puddings, etc. Steamed foods, as a rule, are more highly flavored than those boiled, for the reason that in steaming, the soluble constituents are not so easily lost as in boiling. The process of steaming can be carried out in a "modern steam cooker" or in a perforated kettle which fits closely over another kettle containing boiling water. If the steam is under pressure, the temperature may be much higher than that of boiling water, and hence the method may be used for sterilizing canned foods. In large establishments such as hotels, restaurants and clubs, the method is also used for the baking of meats. Ordinary home steaming is an excellent method of cooking vegetables, hams, fruit cakes, puddings and other dishes that require the prolonged application of moist heat.

LOSSES IN COOKING MEAT

It has been determined by Johnston that, no matter how carefully or by what process meat is cooked, there is always a certain amount of loss of the soluble constituents, for instance:

	In Boiling	In Baking	In Roasting
4 lbs. of beef loss in weight	1 lb.	1 lb. 3 oz.	1 lb. 5 oz.
4 " mutton " " "	14 oz.	1 lb. 4 oz.	1 lb. 6 oz.

The greater part of this loss is water, shown by the following analysis given by König:

COMPARATIVE COMPOSITION OF MEATS BEFORE AND AFTER COOKING

	Water, Per cent	Nitrogenous Matter, Per cent	Fat, Per cent	Extractive Matter, Per cent	Salts, Per cent
Beef:					
Before cooking (raw)	70.88	25.51	4.52	.86	1.23
Same after boiling	56.82	34.13	7.50	.40	1.15
Same after broiling (as beefsteak)	55.39	34.23	8.21	.72	1.45
Veal Cutlets:					
Before roasting (raw)	71.55	20.24	6.38	.68	1.15
Same after roasting	57.59	29.00	11.95	.03	1.43

The actual loss of the soluble matter is more clearly stated in Bulletin No. 21, United States Department of Agriculture. The estimate below is calculated on the basis of dry substances:

COMPARATIVE COMPOSITION OF WATER-FREE SUBSTANCE OF MEATS BEFORE AND AFTER COOKING

	Nitrogen, Per cent	Protein, Per cent	Fat, Per cent	Extractive Matter, Per cent	Salts, Per cent
Beef:					
Before cooking........	12.37	77.31	15.47	2.98	4.24
After boiling..........	12.65	79.06	17.38	.90	2.66
After roasting.........	12.27	76.73	18.41	1.59	3.27
Veal Cutlets:					
After cooking.........	11.39	71.17	22.45	2.32	4.06
After roasting.........	10.93	68.36	28.18	.09	3.37

A careful study of these figures proves that the loss is almost entirely confined to the extractive matter and salts of the meat.

COOKING OF FISH

Fish may be cooked by boiling, grilling, baking, frying or stewing. Of these several processes boiling is decidedly the most advantageous for persons with feeble digestions, and next in order is broiling. The flavoring ingredients of fish are more readily dissolved by water than those of meat, and since fish has less flavor, in the first instance, any loss in this direction is to be carefully guarded against. For this reason, boiling, unless most carefully supervised, is not a suitable method of cooking fish. Even when carefully performed, the loss exceeds 5 per cent of solid matter, and on this account, cooking by means of steaming is preferable just as in the case of some vegetables. When fish is boiled without the addition of salt to the water, it becomes soft and disintegrates, but if boiled in sea water or ordinary water to which salt has been added, the fish maintains its shape and flavor. The quantity of salt regulates the osmosis of the juices of the fish into the water.

As a rule, fish is cooked in much less time than meat. If fried fish is to be eaten by persons of dyspeptic tendencies, it should be cooked whole and the skin carefully removed subsequently. But fried fish is never as easily digested as boiled fish. The essential principle of frying fish consists in the sudden exposure of the object to be cooked to a very high temperature, which, as we have seen in the section on frying, has the effect of producing an instantaneous coagulation of the albuminoid

matter on the surface, together with a slight degree of charring, thus preventing the escape of juices and other soluble substances, while the surrounding temperature is so high that the fish is practically cooked through its whole thickness almost instantaneously.

In order to attain the proper temperature for frying fish, olive or good cottonseed oil is the best medium. A deep pan is necessary, and a temperature of from 350° to 390° F. When this temperature has been reached, the fish should be suddenly plunged into the pan and left for 2 or 3 minutes. Considerable spluttering will immediately ensue, and when it ceases, the cooking will be complete.

COOKING OF VEGETABLE FOODS

The objects to be achieved in cooking of vegetable foods are somewhat the same as in cooking animal foods, namely, to render them more digestible, to give variety, to modify their flavor and in some cases to preserve them. While it is possible but not practicable to eat animal foods without cooking, yet it is impossible to eat certain vegetable foods in a raw state, as man is almost incapable of digesting the cellulose framework of vegetable foods; hence, cooking in order to soften this cellulose framework, and to bring about a gelatinization of its starch, are the ends to be desired in cooking vegetables. Cellulose, as we found when studying vegetable foods, is a very hard, indigestible substance in its raw state, or until it has been partly converted into sugar by the action of acids, aided by heat. It is probable that this change does not ordinarily take place in cooking or in digestion. In ripening fruits such change is due to enzyme action. In its unripe state, a pear or other fruit is very hard and "woody," due to the presence of this cellular framework. In the process of ripening, the acids of the fruit, aided by the heat of the sun, bring about a softening of this framework with partial or more or less complete solution of the cellulose fibers, producing, when ripened, a sweet, soft fruit.

In the cooking of vegetables the cellulose envelopes are burst asunder in consequence of the heat, so that when ingested, the digestive ferments of the alimentary canal have more ready access to the starchy or albuminous contents. In bread and other glutinous foods, the albumin is coagulated, and in the case of bread, it sets in a permanent vesicular mass which the digestive secretions readily permeate and attack. In the cooking of green vegetables, the fibers are softened, the albumin coagulated, the gummy, saccharine, saline and oily matters are, to a more or less extent, partially removed by the water. It should be unnecessary to state here that all vegetables need thorough washing before cooking. Roots and tubers,

especially, should be well cleaned before paring. As a general rule, all vegetables to be boiled or stewed should be cooked rapidly with just enough water to prevent burning and with the lid off the saucepan; the rising scum should be frequently removed. Rain water is especially adapted for cooking on account of its softness and freedom from salts of lime and magnesia. These salts are present in hard water, and when vegetables or meat are boiled in it, a certain amount of salts is deposited, thereby increasing the scum. When these salts are deposited upon the meat or vegetables, they hinder the penetration of heat into the interior, and so their presence may prevent the abstraction of soluble materials when it is desired to make broth or soup.

GAIN OF WATER ON COOKING VEGETABLES

	Per cent of Water in Raw State	Per cent of Water after Cooking	Increase
Parsnips	82.0	97.2	15.2
Artichokes	80.0	91.6	11.6
Cabbage	89.0	97.5	8.5
Spinach	90.0	98.0	8.0
Cauliflower	90.8	96.4	5.6
Sea-kale	93.3	97.9	4.6
Vegetable marrow	94.8	99.1	4.3

Some coarse, raw vegetables—principally the roots and tubers, such as turnips, carrots, beets and potatoes—while they make good food in the raw state for animals, are unpalatable and indigestible for man, and require softening and alteration by prolonged boiling in water or some other form of cooking. The action of heat through boiling macerates the cellular fibers or walls of the cells, softens their contents and renders the vegetables more easily masticated, while the effect of the heat, together with the accompanying moisture, causes swelling and rupturing of the starch grains, in which condition the vegetable matter is more easily and promptly acted upon by the starch digesting enzymes contained in the saliva and pancreatic juice. Many vegetables are better steamed than boiled, as, for instance, potatoes, rice, young peas, corn, squash, cucumbers, pumpkins and spinach. The effect of cooking upon green vegetables, in some instances, is to decrease their already poor stock of nutrients. They gain water and lose part of their carbohydrate and protein content, much of their mineral matter and nearly all of their non-albuminoid nitrogenous constituents. For example, in cooking cabbage by boiling,

more than 30 per cent of its total solids is lost, as well as a large amount of the total mineral matter, and one-third of the carbohydrate, all of the non-protein nitrogen, and 5 per cent of the protein. Some of the commoner vegetables gain a large percentage of water in cooking, as shown in the table on the opposite page(6):

We append below a table(7) showing the amount of carbohydrates contained in some of the commoner vegetables before and after cooking:

	RAW	AFTER BOILING AND STRAINING
	Per cent	Per cent
Cabbage, turnip (young)	3.09	2.43
Cauliflower	2.10	1.40
Spinach	2.97	.85
Winter cabbage	6.75	3.20
Asparagus	....	1.6
Savoys	2.7	....

The deficiency of fat in vegetables is often made up by the addition of butter or oil in the course of preparation for the table. Vegetables prepared in this way may be made an important vehicle for conveying fat into the body. The amount of fat which some vegetables can readily take up without being overloaded is shown in the following table:

100 parts of potato purée	can take up	50 parts of fat
100 " " boiled potato	" " "	40–50 " " "
100 " " baked "	" " "	40–50 " " "
100 " " red cabbage	" " "	40 " " "
100 " " savoy cabbage	" " "	32 " " "
100 " " cabbage lettuce	" " "	24 " " "
100 " " potato soufflé	" " "	20 " " "
100 " " fried potatoes	" " "	15 " " "

Vegetables are not, on the whole, readily digested. It has been shown that five and one-third ounces of cabbage require three hours. The same amount of cauliflower requires only two and one-half hours. Certain vegetables are difficult to deal with in the intestine owing to their bulk and the amount of cellulose which they contain. If they are slightly stale, their presence in the intestines causes fermentation with the generation of gases due to the action of the organisms on the cellulose. The action of heat on the protein contained in vegetables has an effect similar to that which it exerts on the same constituent of animal food; the coagulation of protein produces a shrinkage rather than a swelling of the food, and for this reason, if the cellulose framework encloses protein only, it does not rupture. One can readily understand, therefore, that if a vegetable food contained only protein, its digestibility would not be increased by cooking, but rather decreased. As a matter of fact, however, there are few vege-

table foods which do not contain much starch together with the protein, and hence it is that the general rule holds good, that cooking increases the digestibility of all vegetable foods.

FOOD CONCENTRATION

Food concentration is based upon the fact that the large percentage of free water contained in some foods can be removed by evaporation. This process reduces the weight and at the same time the bulk of the food. Further condensation may be accomplished by pressure with hydraulic machinery applying several tons of force to the square inch.

Desiccation.—Desiccation involves the removing of more water from foods than can be removed by evaporation alone. Such food products are commonly refered to as "condensed." Desiccation may be carried to the point where the food is entirely dry, in which case the substance "desiccated" may be torn into shreds or pulverized. Condensed and powdered foods are usually added to other foods in order to thicken them or add to their nutritive properties. Desiccated meat is the most concentrated form of protein, sugar is the most concentrated form of carbohydrate, and olive oil is the most concentrated form of fat.

Concentrated Proteins.—Concentrated proteins are prepared from milk, meat, eggs and vegetables. Meat is concentrated by drying, and in this form is practically indigestible. This indigestibility can, however, be overcome by predigestion or powdering. This class of foods includes beef meal, somatose and other such products (*see* page 20). Of the concentrated vegetable proteins may be mentioned aleurona and legumin.

Dried Vegetables.—Dried vegetables keep much better than dried meats. Coffee, tea and cocoa are good examples of dried vegetable substances. They may be extracted and then concentrated by evaporation. Potatoes are concentrated by a drying process to less than one-third of their weight, and in this shape may be preserved for future use; so may carrots, cauliflower and the like. They are prepared by being exposed to the direct rays of the sun, and are serviceable only for relieving monotony of the diet when fresh vegetables cannot be obtained. (*See* Volume II, Chapter II.)

Desiccated Vegetables.—Desiccated vegetables have been used to some extent in the United States Navy, but it has been found that they possess fewer antiscorbutic properties than fresh vegetables. Bread is frequently dried and eaten in the form of "hard-tack" when it is impossible, as during long voyages, to obtain fresh bread. Hard-tack may be preserved for a long time, but it becomes tasteless and is useful only in emergencies.

Captain Woodruff(8), of the Medical Corps of the United States Army, writes on this subject as follows:

> The Germans have been the first to take advantage of drying and compressing processes in the manufacture of a dried, compressed bread. The great difficulty in the use of bread for field use consists in the inability to supply it so that it will keep a long time and be digestible. Hard-tack is ruinous to many soldiers, as already pointed out. If baker's bread is compressed, it sinks into a heavy dough. Only strong stomachs can digest it, and it is far worse than the soggy, hot breakfast bread with which we cultivate dyspepsia. If the bread is merely dried, it is too bulky for transportation. By a new process, which probably consists in drying the bread and at the same time compressing it by improved machinery, the Germans have secured a variety of field bread which is spoken of in very high terms. Small bits of it thrown into soup swell up like a dried sponge when thrown into hot water. The soldiers are said to be very fond of it, and as far as known it is entirely successful.

Desiccated Milk.—This is now prepared by drying *in vacuo* fresh cow's milk. It is offered as a sterilized food for the artificial feeding of infants (*see* Volume II, Chapter II).

Desiccated Eggs.—These are also offered as a substitute for fresh eggs, but the product is very inferior to fresh-laid hens' eggs. The albumin of egg dries in thin scales which may be indefinitely preserved, but the yolk is not so well taken care of.

Dried Meat.—The preservation of meat and fish by drying is probably the oldest of the primitive methods of preserving meat. This method of drying meat is practiced extensively among savage tribes in most parts of the world, but especially where purity of atmosphere combined with intense heat and dryness of climate will cause the water to evaporate from the meat so rapidly that germs do not have time to decompose it. Meat to be preserved in this manner must necessarily be lean, as the fat does not part with its water with sufficient rapidity. Dried meat loses considerably in weight, becomes hard and tough, and in many instances tasteless. Such meat is usually very indigestible, and requires prolonged cooking and liberal seasoning. Dried meats may be predigested, evaporated and made into a paste for broths or used to reënforce various food preparations for invalids. Meat extracts have been described in Vol. I, p. 287.

Concentration, according to Colonel Woodruff(8), means only the extraction of the indigestible portions of the food and part of the water. Thus the garrison ration gives to each man about five pounds of food, of which only four pounds are eaten, and it is impossible to condense this amount so that it will be much less than three pounds. All foods that are compressed and dried still contain from 5 to 12 per cent of water. The

German soldier's war ration is equivalent to about two pounds of water-free food in the above sense. This is not enough for American soldiers during hard work, yet it is possible in an emergency to give the soldier fairly good nourishment with these improved foods, and not allow the weight to be over two pounds, as seen in the following table, in which the analyses are only approximate:

COMPOSITION OF EMERGENCY RATION OF THE GERMAN SOLDIER

Articles	Grams					
	Protein	Fats	Carbo-hydrates	Salts	Calories	Weights
3 cubes dried compressed bread, ¼ pound each...	35	4	250	2	1,233	¾ lb.
3 packages compressed soup, 6 ounces each.........	100	150	200	28	2,625	1⅛ "
3 tablets compressed tea or coffee ready for use, possibly a tablet of dried fruit................	...	...	...	..	....	⅛ "
Total..............	135	154	450	30	3,858	*2 lbs.

* Gross Weight.

The composition of the bread is assumed to be the same as ordinary flour, and the tablets of soup can be manufactured of the given composition. As usually made, the tablets do not contain so much fat, which is here purposely increased in order to give the necessary energy. Even with this increase they would not contain as much as the first specimens of Erbswurst.

For purposes of detached service the United States soldier has been supplied as follows:

COMPOSITION OF COMPONENTS OF THE RATION OF THE UNITED STATES SOLDIER

Components of Ration	Grams					
	Protein	Fats	Carbo-hydrates	Salts	Calories	Weights
1 pound hard-tack........	50	5	340	2½	1,644	1 lb.
¾ pound bacon..........	27	236	...	8½	2,310	¾ "
Coffee, sugar and salt.....	..	...	...	19	....	¼ "
Total..............	77	241	340	30	3,954	2 lbs.

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CHAPTER IV

THE HYGIENE OF EATING

The Creator in compelling man to eat that he may live, invites him through appetite and rewards him with pleasure.

The Rôle of the Senses in the Pleasure of Eating.
Effect of the Manner of Eating on Digestion: Euphagia; Food and Emotion; Bradyphagia; Tachyphagia; Evils of Overmastication.
The Drinking of Water with Meals.
Personal Idiosyncrasies.
Order and Frequency of Meals: For Healthy Individuals and in Diseased Conditions; For Persons Engaged in Heavy Manual Labor, Skilled Labor, Professional Vocations, Commercial Life; For Those Who Lead Lives of Leisure; For Night Workers.
Regularity of Meals.
Sleep and Digestion.
Occupation and Digestion.
Variety in Diet.
Relation of Medication to Meals.

THE RÔLE OF THE SENSES IN THE PLEASURE OF EATING

The above quotation is a sublime aphorism of the great deipnosophist who regaled his readers with a vast abundance of gastronomic lore, emphasizing the correlative influences of the five senses on the pleasure of eating.

"True it is that nearly all animated beings are endowed with special senses, but man, alone, is granted the faculty of cultivating them to a very high degree for bodily nourishment and mental enrichment as well as for other purposes. Forced by hunger to eat for his sustenance, he labored diligently in seeking the necessary aliments which, originally, he had found through the aid of certain lower creatures whose movements he had cunningly espied. The first sense he naturally exercised was that of *sight;* the second, *touch,* when with his hand he seized an edible substance and carried it toward a third sense organ which gave him its *odor,* then greedily thrust it into his mouth to awaken the *gustative* sense; the clattering of his teeth pleasantly rousing the *auditive* sense. Thus were

the five senses gratified whilst hunger was satisfied; appetite, that is to say, the desire to eat tasty food, became agreeable, being the outcome of that primitive experience."

The high cultivation of the senses in man gives him supremacy over other animated beings in his struggle for existence. In the animal kingdom, as well as among uncivilized peoples, the securing of food for sustenance forms the principal occupation during life. The necessity of obtaining food has remained the same with civilized man, but the manner of partaking it has been changed, partially to his disadvantage. New interests have arisen and the act of eating has been in a measure relegated to the background. In this age of frenzied finance, in busy metropolitan centers, persons scarcely take time to eat; they swallow hastily any kind of food, without special selection, which is often very poorly prepared. The natural consequence is that under these conditions diseases of the alimentary system are more frequent than in the early days.

Individuals whose sense organs are abnormal, whose perceptions are naturally dull or accidentally obtunded, or whose mental faculties are untutored, have little if any real pleasure in eating. "Hunger and thirst they feel, and beast like, brutally appease, but they have no true appreciation of, or appetite for, dainty food or for its use in moderation; whilst those of cultured mind and sound body, in the enjoyment of delicacies, bring into play all of their senses to enhance the pleasure of eating." This is aptly summed up in the aphorism:

The beasts feed, man eats, but only men of genius know how to eat.

"The gustative sense, one of the most precious endowments of the Creator to the creature, is granted to nearly all animated beings, but man alone is able to cultivate this sense to its highest possibilities. Probably prehistoric man, from watching an animal in the act of ingesting food, tried it, but found it malodorous, nauseous, unsavory, so he rejected it. Finding another kind of food in which he perceived a fragrance and sapidity, after bruising it in his mouth, he swallowed because of the pleasing buccal sensation it produced. Gustation, therefore, may be defined as the perception and distinction of savory and unsavory qualities of ingesta.

"Taste, like many other words pertaining to the alimentation of man's body, is largely used figuratively, as in the expressions "good or bad taste" or simply taste or its want, *"de gustibus non est disputandum"* being applied to both the original term and its figurative use. For instance, an aliment may be gustful to one individual and disgustful to another.

"The seat of gustation is at the base and sides of the tongue, the base

being the region of the circumvallate papillæ, and the side the region of the fungiform papillæ. The exquisitely delicate filiform papillæ, disseminated upon nearly the whole upper surface of the tongue, are purely tactile, while the gustatory papillæ are furnished with taste bulbs. Besides ramifications of twigs from the glossopharyngeal nerve and lingual branch of the trigeminal, the circumvallate papillæ contain minute gustative bulbs (discovered by Schwalbe and Loven in 1867). These gustative bulbs exist also in the fungiform papillæ. Thus the chain of specializing bodies in the sense end-organs is complete, from the retinal rods and cones, the tactile corpuscles and pacinian bodies, the olfactory cells in the upper yellow region of the nasal mucous membrane, to the organs of Corti in the internal ear."

Tasty aliments are often designated as "palatable," although the palate is passive in gustation, its office being purely mechanical and serving as a hard, fixed surface against which the tongue bruises the food to express and diffuse sapid particles for quick solution by the saliva, without which there would be no gustation of solids. The other parts of the buccal cavity possess no more than tactile properties.

It has been stated by competent physiologists that there are but two veritable savors recognizable through the gustative bulbs, namely: the sweet and the bitter; while others equally competent have identified three additional savors: the saline, the alkaline and the acid. However, sweet, bitter, salt and sour are almost universally accepted. But all reject the idea of acrid savors, which really result from mechanical action of acid substances upon the tactile papillæ, and ignore the so-called aromatic savor which belongs to olfaction. Nevertheless the concurrence of the tactile and olfactory senses is essential to perfect gustation and to the full enjoyment of delicious aliments.

Taste, then, with its closely associated olfactory and tactile senses, is regarded, gastronomically, as the special and general pleasure evoked by the perception and specialization of the crispness, of the succulence, sapidity, and perfume of aliments; and figuratively as a judgment of the beautiful, the sublime and the picturesque.

The proper hygiene of eating is too often unjustly decried as sybaritism by the thoughtless; but students of rational deipnosophism admit that the wise cultivation of the divine gift of the five senses is not only essential to the real enjoyment of edibles but is a blessing without which man would be but little above the beast. The pleasure of eating should be the reward for the labor of gathering, preparing, serving and consuming the food.

In observing the proper hygiene of eating, it behooves one to insist that wholesome aliments be rendered appetizing and pleasing to the senses; only ascetics denounce a gourmet by saying, "It is bestial to make eating an absorbing object of thought. A man should eat to satisfy hunger; but if he allows his mind to run on his food, he will become a glutton and beast at the cost of his soul." Such a charge, while not really applicable to the gourmet, could only have been made by one known to live on the commonest of foods and one whose gustative sensibility has long since been obtunded and who does not care for good fellowship. It is only too well known that the veritable gourmet always has a good cook, and is never gluttonish. He is a daintier eater, only giving sufficient thought to his daily food to insure its excellence of quality, and regarding a moderate and reasonable gratification of appetite and gustative sense as pertaining to human intellect, and the mere satisfaction of hunger as of beastly instinct. The gastrolater is one who makes eating "an absorbing object of thought" and who in brutish style devours large quantities of food, regardless of quality. He does not become gluttonous, for he was born a glutton.

"Good alimentary hygiene, like good German grammar"(1), involves a clear knowledge, first of rules, then of exceptions, and finally of exceptions to exceptions. An ideally healthful, well-regulated life involves painstaking regularity in eating, drinking, sleeping, exercise and moderation, as well as avoidance of risks. But it is occasionally necessary to resort to irregular and excessive demands even to the point of danger, in order to develop moral, mental, muscular or digestive strength, and the "exception to the exception" is that one must be careful not to make irregularity itself a routine, nor to make the physical test a strain nearing the danger point, nor to disregard carelessly the experience of other observers, or even his own, in running risks.

Eating or partaking of food is the only means by which life is sustained. Without it the human organism cannot thrive, cannot gain in weight, cannot grow. Total abstinence from food causes the body to lose steadily in weight, and results in death.

EFFECT OF THE MANNER OF EATING ON DIGESTION

Euphagia.—Euphagia, or the art of eating properly, like all natural processes, if performed under the proper hygienic conditions, affords the body the greatest pleasure and satisfaction. In order to receive the greatest pleasure from the partaking of food, the organism must be prepared by

previous work, followed by a short period of rest. In Holy Writ, we find a quotation: "In the sweat of thy brow shalt thou eat bread," which emphasizes the importance of work preceding the partaking of food. A German proverb, "Arbeit macht das Leben süss" (Work sweetens life), emphasizes not only the pleasure derived from eating, but from all other functions of life. Even if it is admitted that work is essential to the pleasure and satisfaction of eating, still it must not be in excess or lead to exhaustion, as in this condition the appetite usually lags and digestion becomes sluggish.

Food and Emotions.—Meals should be served only after a short period of rest, allowing plenty of time for the repast. During mealtime the emotions should not be disturbed, either by anger or grief. The whole and undivided attention should be given to the meal(2). Pleasant company, light conversation, jokes and stories add to the enjoyment of food. It is well understood that the brain exerts a powerful influence on the process of digestion. Great grief or anger deters appetite and may seriously hinder the process of digestion.

Pavlov(8) has established, beyond question, the great physiological importance of the mental state on digestion, having successfully demonstrated that the sight of delicacies exerts a stimulating influence upon the secretion of gastric juice even before the viands are eaten. Food to be enjoyed must not only be properly prepared and palatable but must be served in an attractive manner. There can be no question that a well-laid table, snow-white linen, polished silver, crystalline drinking vessels, beautiful floral decorations, and the good taste displayed in all the appurtenances of a well-ordered dinner, delight the visual impression with each course throughout the repast and heighten the pleasure of eating.

Physiologists and dietitians guided by the work done by Pavlov and Cannon on digestion and nutrition are realizing more and more the potency of the psychic factors concerned in the process of digestion, and he who comprehends only the chemical and mechanical aspects of these all-important questions sees as "through a glass darkly" and needs to sweep the cobwebs from his brain.

When a hungry diner approaches an attractively laid table with an appetizing meal thereon, both his eyes and olfactories set in motion the preliminaries to the digestion of the food in sight. As the food is received by the waiting gustatory tract, it is comminuted and insalivated just sufficiently to promote easy deglutition and allow the savory taste and aroma arising therefrom to be thoroughly appreciated. During mastication numerous messages are dispatched to the stomach, the pancreas, the

duodenum and the other organs concerned in the process of digestion, informing them in code message readily understood how much and what kind of aliment is being dispatched to them to digest. When such messages are of cheerful import, these organs at once take to their tasks with alacrity, performing them with such ease and expedition that the diner need not know that he even possesses a stomach.

But, on the other hand, should the same meal be approached with severe gastronomic contemplation and with arduous and lengthy mastication, the message may be "flashed" to the waiting accessory organs, "Your master has lost confidence in you; the mouth and teeth will take over most of your former duties, and hereafter you will be under constant mental surveillance." It can readily be perceived that under such a mental state digestion is performed in a tedious, faulty, complaining and unsatisfactory manner, and we may well say that "the last state of that man is worse than the first."

The effect of the emotions on digestion has, until recently, received scant attention at the hands of physiologists; in consequence, our knowledge of the emotional states on the process of digestion has been meager. Cannon(2) has placed before the profession the result of his four years' study of this subject in the Harvard Physiological Laboratories, and his published researches have thrown light on a hitherto dark subject. We are well acquainted with many surface manifestations under strong emotion. The contraction of the blood vessels with resulting pallor, the pouring out of "cold sweat," the stopping of the flow of saliva so that the "tongue cleaves to the roof of the mouth," the dilation of the pupils, the "rising" of the hairs, the rapid beating of the heart, the hurried respiration and the trembling and twitching of the muscles, especially those about the lips; these bodily changes are well-recognized accompaniments of pain and great emotional disturbances, such as fear, horror and deep disgust. These manifestations of the emotions commonly noted are mainly superficial and readily observable. The internal organs of the body do not reveal so obviously the disturbances of action which attend states of intense feeling. The organs most affected to an important degree by the feelings are those concerned with digestion.

Cannon, in his recent investigations, has shown that not only are "the first stages of the digestive process normally started by the pleasurable taste and smell and sight of food, but also that pain and great emotional excitement can seriously interfere with the starting of the process or its continuation after it has been started." The conditions favorable to proper digestion are wholly abolished when unpleasant feelings such as

vexation, shame, worry and anxiety, or great emotions such as anger and fear, are allowed to prevail. It has long been known that the salivary secretion is seriously affected by fear or "stage fright"; and the "ordeal of rice," employed in India to detect criminals, was a practical utilization of the knowledge that excitement is capable of inhibiting the flow of saliva(3).

Other digestive glands than the salivary and gastric are influenced in emotional excitement. Oechsler(4) reports a study of psychic disturbances showing that emotional excitement suppresses secretion of the gastric juice, the secretion of the pancreatic juice and definite hindrance of the flow of bile. The secretion from the various organs concerned in the process of digestion and the chemical changes produced by them are of little value unless the chyme is normally propelled along the alimentary canal, and just as the secretory activities of the stomach are unfavorably influenced by the strong emotions, so also are the movements of almost the entire alimentary canal practically arrested under great excitement. Cannon, by means of the roentgen rays, the most fruitful of all the technics applied in this field of study, was able to observe the movements of the alimentary canal in animals, and in some of his experiments the waves of contraction were perfectly evident, while in others there was not the slightest sign of activity. The peristaltic waves in the stomach, and the peristalsis in the small intestine, and reversed peristalsis in the large intestine all ceased when the observed animal was in a state of emotional excitement.

Other sensory stimuli bring about similar inhibitions of gastric peristalsis which can actually be observed in certain animals (rabbits) without any operative interference whatever, by mere inspection of the epigastrium as described by Auer(5). The stoppage of intestinal peristalsis, after similar inhibitory influences are brought to bear, has been described for the human subject by various observers who used the roentgen ray method. If further evidence were needed to give emphasis to the profound dependence of the activity of the stomach, as regards both its secretory and motor functions, on the "condition" of the nervous system, additional proofs could easily be adduced. Quite recently a large number of facts have been gathered in the pharmacologic institute at Utrecht directly applicable to the question at issue. They involve a careful record of the rate of discharge of bismuth meals from the stomachs of laboratory animals in various stages of psychic calmness or perturbation, but under otherwise comparable conditions. Without attempting to group the emotional states into well-defined categories, we may describe the subjects as ranging from

individuals tame, unperturbed, readily amenable to handling and freely submissive to observation, on the one hand, to wild, frightened or refractory subjects on the other. Corresponding with these emotional states the discharge of the meal from the stomach ranged in time from one and a half hours in the former group to three or even more hours in the case of the most unamenable subjects. Such figures are more expressive than a dozen sermons on the importance of a proper state of the nervous system in the normal performance of some of the functions of alimentation.

The conclusion is that the activity of the stomach in man is affected similarly to that in the lower animals; so, likewise, the gastric and intestinal peristaltic waves are stopped in man as they are stopped in lower animals by worry, anxiety and other conditions of mental discord. Thus we see that the emotional life of an individual exerts a marked influence upon all gastro-intestinal activity. Fully 50 per cent of the action of gastric secretions is psychic and at least partially dependent upon hedonistic approach. The intrinsic relationship between man's emotional state and the operation of his primitive instincts is axiomatic. In the field of nutrition, the proper selection of nutritional elements is a matter of protoplasmic activity of the original cell.

An individual in normal health, taking a reasonable amount of exercise, does best to follow his natural appetites with regard to quantity and quality of food, though an intelligent appreciation of physiologic demands and the nature of the aliment is always of considerable value. Sanitarium life is particularly demoralizing to persons who think too much of their digestive physiology. Society matrons and débutantes who have nothing to occupy their minds except dress and eating, become morbid from thinking too much of what they shall wear and particularly of what they shall eat. Some physicians, too, become health cranks from constant application of their professional ideas to themselves and their families. Health cranks of all kinds are usually the product of imperfect, unqualified information carried to an extreme in one direction.

Bradyphagia.—One of the most prominent advocates of this class, in recent times, is Mr. Horace Fletcher(6), an apostle of deliberate mastication—*bradyphagia*. He has so largely devoted his energies to this topic that slow eating has come to be called "fletcherism."

Mr. Fletcher, when about to pass the middle milestone in life's journey, found himself obese, dyspeptic and discouraged; at this point he discovered that by slow and deliberate mastication his health seemed to improve. He then began to elaborate this supposedly new principle, claiming that he literally chewed himself back into normal health and averring that

by extreme mastication and insalivation of food, hunger was satisfied with a much smaller amount than ordinarily craved, while at the same time his physical and mental well-being were enhanced. Mr. Gladstone, an Englishman, anticipated Mr. Fletcher as the first advocate of prolonged mastication and attributed much of his success in public life to the fact that he had always made it a rule in eating to give every tooth a chance at the chewing.

Bradyphagia means eating too slowly—a condition in which mastication is performed at an abnormally slow rate, often leading to injury of the body economy. Mastication normally is an entirely voluntary act, while the performance of swallowing is a complicated reflex movement which is usually initiated voluntarily, but is, for the most part, completed involuntarily. Under normal conditions the presence on the tongue of masticated food seems essential to the completion of this act, and we might add that a pleasant taste coupled with a favorable attitude still further facilitates the act of swallowing and the passage of food through the esophagus into the stomach.

Prolonged mastication may be, and often is, overdone by many people to their detriment. In many cases every morsel is masticated and remasticated, carrying out the Gladstone dictum of 32 bites for each morsel, and before being swallowed is again chewed and everything carefully tested with the tongue to see that it is thoroughly comminuted. The fletcherite has an abnormal fear and suspicion that something dreadful will happen unless he masticates his food as laid down by Fletcher in his "A B C of nutrition," which as a theory has grown, budded and blossomed so popularly that eating has become a difficult task. The enjoyment and pleasure of eating are transformed into a doleful process and a much smaller quantity of food is ingested. It not infrequently happens that the bolus of food remains in the pharynx or esophagus and refuses to budge. It is not an organic affection that causes this dysphagia, but merely excitement and fear of eating. In such individuals, of course, in time a chronic inanition develops owing to bradyphagia and the added temporary dysphagia, in consequence of which the patient gradually becomes weaker and sometimes even dies.

We admit the necessity for the moderate chewing of meats and urge the most thorough mastication of carbohydrate foods. In diseased conditions with impaired chemical functions of the stomach, or where a neoplasm constricts the pylorus, fine mastication and thorough insalivation of foods are not only highly beneficial, but necessary. Fletcherism is also permissible in those easy-going, lackadaisical individuals whose tastes are

gently epicurean and who possess the desires of a Lucullus minus the means. Let those benighted harmless souls chew and champ to their heart's content, for they, poor beings, need some fad, and this one can harm no one unless it be themselves. But to busy men who are shouldering the cares of government, commerce and science, and whose strenuous impetuosity moves them to act quickly, whose every act is intense and every movement a flash—to such individuals, fletcherism is a thorn in the flesh.

Einhorn(7) reports a case of bradyphagia—a lawyer 32 years of age, who consulted him for digestive disturbances and gave a history of having lost considerable flesh and of being unable for the previous three years to attend to business. He complained of an inability to swallow food and of intense pains in the upper abdominal region particularly after meals. This patient had lost more than 40 pounds, of which only a small portion was lost during the previous six months. He was a strict follower of the ideas of Fletcher; he ate very slowly, taking as long as half an hour to consume a glass of milk. He was emaciated, and an examination of the thoracic organs gave negative results. The lower border of the stomach reaching two inches below the navel, the epigastrium was slightly sensitive to pressure. Examination of the stomach contents after a test breakfast showed the presence of free hydrochloric acid with an acidity of 78. Dr. Einhorn's diagnosis was neurasthenia with hyperchlorhydria, and upon his advice the patient was given a more liberal diet and advised to eat more rapidly. In three weeks he gained eleven pounds and continued to gain in weight and entirely recovered. The difficulty of this patient in eating and swallowing is explained by the psychic excitement subsequent to the sitophobia and bradyphagia.

Tachyphagia.—Tachyphagia, or hasty eating, is a common evil. The food is only half masticated or possibly not at all, and enters the stomach without being properly comminuted and insalivated. Such practice will surely lay the foundation for many disorders of the stomach and be a fruitful cause of intestinal auto-intoxication. Food which is not properly comminuted will be the means of irritating the gastric mucous membrane and will not be sufficiently acted upon by the gastric juice which affects only the external surface. More particularly does this refer to the digestion of albuminoids. Carbohydrate foods when eaten too rapidly enter the stomach with only slight alteration, due to the rapidity of mastication and swallowing, wherein the ptyalin of the saliva is not present in sufficient quantities to produce any effect on the preliminary digestion of starches. The chyme, as a result of imperfect mastication and imperfect admixture

with the gastric juices, passes out through the duodenum practically unchanged and is liable by its coarseness to produce an irritation of this organ.

Tachyphagia has other drawbacks besides the mechanical effect just mentioned, as it includes the taking of larger quantities of food in too short a time and the ingestion of foods too hot or too cold. In observing the proper hygiene of eating, provision is made that not too much food passes into the stomach at once, for mastication requires time; besides, in dining congenially, some time is spent in conversation and in serving of the different courses. Food that is too hot or too cold has its temperature somewhat equalized by the slow passage through the mouth and esophagus. These important factors are not observed in eating too rapidly. It is therefore plain to the careful student of euphagia that in too rapid eating an unsuitable quantity of food at unsuitable temperatures is consumed; both conditions being a fruitful cause of digestive disturbances. Tachyphagia, or too rapid eating, is a frequent fault, causing many digestive qualms, and initiating many chronic disorders of the alimentary canal. This we admit. But we do *not* admit the necessity for slow, deliberate and systematic mastication as a *sine qua non* for health in every individual, irrespective of temperament, occupation or station in life; nor do we believe it conducive to the best physiological work of the digestive organs that a hard and fast rule be enjoined whereby a certain stated period of time must be devoted to mastication regardless of the nature of the food or the pleasure of the masticator.

Evils of Overmastication.—Insalivation exerts but little physiological effect upon the protein constituents of food. According to the teachings of physiologists, we know quite well that either the pepsin and hydrochloric acid in the stomach or the trypsin beyond will take care of the digestion of meats provided they are decently comminuted and stay in the mouth only long enough to originate those psychic impulses which Pavlov(8) has so well shown us regulate the subsequent flow of the digestive juices. Every observer who has watched carnivorous animals feed, knows that they habitually bolt their food, and zoölogical history records no account of any psychic forms of dyspepsia in these animals. The principal function of salivary digestion is the preliminary transformation of starch into maltose by the action of ptyalin, and this process, though inaugurated in the mouth, continues until the whole of the stomach content has become acid. The time of salivary digestion, though quite brief, to be effectual should be energetic. Primarily, it is a preliminary act and no more should be expected of it than this. The pancreatic and other

juices beyond the pyloric end of the stomach will take care of the digestion of carbohydrates, and the psychic centers will forward the message regularly and rapidly as received by the gustatory senses.

After all, we might say, and say correctly, the rapidity of chewing is temperamental. We all know that some people can perform a given task, and perform it well, in half the time required by slow-moving individuals who do everything along the lines of least resistance; and as some people act quickly, speak quickly and think quickly, they also chew quickly but well. Men of affairs in the business world, those engaged in professional activities, soldiers, statesmen, and what not—ardent and strenuous spirits—are happiest when in the busy turmoil of competitive struggle; with them, the act of mastication is naturally performed briskly but none the less adequately. While on the other hand, the easy-going meanderer, who always seeks the lines of least resistance, goes through life in a leisurely, lackadaisical way, "far from the maddening world's ignoble strife." To these semivaletudinarians, whose gastronomic functions are constantly under severe mental scrutiny, fletcherism holds out promises for their digestive and intestinal qualms.

Time is too precious, and life too short, to spend an unnecessary part of both in useless, if not harmful, mastication. Fletcher records in his writings that "one-fifth of an ounce of a young onion required 722 chews before it disappeared through involuntary swallowing," and Dr. Kellogg records the history of a patient who devoted never less than one and one-half hours in partaking and masticating his one scanty daily meal. It is preposterously asinine to suggest that busy, active men—those upon whose shoulders rest the burdens and perplexing cares of government, commerce and science, whose bright intellects are eagerly conquering the earth, the sea and the air, should be subjected to a too prolonged and wearisome mastication which is a snare and a delusion—a foolish fad—an anachronism in our twentieth century civilization.

A retired business man—cadaverous looking and dyspeptic—consulted Niles(9), informing him that up to his retirement from active business, five years previous, he had never experienced a digestive discomfort during his strenuous years of laborious business activity. He hurriedly ate his breakfast so as to reach his office betimes. He snatched his lunch at a near-by restaurant, and his evening meal or dinner was frequently rushed through in order to keep some important business or social engagement. The subject of prolonged and tedious mastication had never entered his mind, nor did he realize that he was "digging his grave with his teeth," until he was so informed by an over-zealous acquaintance, made some time

after his retirement from business. With this idea implanted in his idle mind, and with little else to do, he began to devote himself assiduously to fletcherizing his food as a safeguard to his future health. Niles reports that as a result of too much thought given to his digestive organs, there resulted a morbid introspection which gradually transformed a robust, alert business man into a puny, whining individual full of pains and obsessions, whose every waking thought was short-circuited on his stomach.

Napoleon(10) at 35 years had developed and rounded out into a fullness that indicated abounding health and vigor, and at the same time his mental faculties had reached their acme. His power for work had apparently never been equaled by any other man. He on one occasion said there was no limit to his endurance. Even his enemies declared that his capacity for strenuous work equaled that of four men. His digestive powers were perfect. He preferred plain dishes well cooked, his meats browned, and he rarely spent more than from seven to twelve minutes at a meal. When he became emperor and reached the pinnacle of his success, like many other successful men, he began to pay too much attention to eating, to the consideration of bodily comfort, and less attention to exercise. The result was he became obese, and at forty his physical powers began to decline and his grasp on the world slackened.

In Volume I, Chapter V, in the section on the Chemistry and Physiology of Digestion, we discussed the mechanical and chemical changes occurring in the stomach and intestines during digestion. It will be seen on referring to this section that each division of the alimentary tract has its rightful duties in the life-scheme of nutrition, and the magnification of any one of these duties is liable to prove an opening wedge for various digestive ills, which, like jealousy, furnish the food upon which they feed and thrive.

We are of the opinion that Americans eat too much butcher's meat and comminute it to an unnecessary fineness which, according to our theory, is not only unessential, but contrary to nature. All carnivorous animals bolt their meat, and we have no recorded observation of these creatures suffering from any form of digestive disturbances. In the first place, meats can only be digested in an acid medium. The gastric juices of the stomach are markedly acid, and it is necessary for meat to remain in the stomach from three to four hours or longer in order to be digested.

Our belief is that meat which is too thoroughly masticated and macerated will be forced into the duodenum before the acid gastric juices of the stomach have had time to prepare it for digestion. It is well known from experience, that eating sausage or hamburger steak produces trouble

during the process of digestion, which is explained in this way. The meat from which sausage and hamburger steak are made is reduced to a very fine pulp with a machine, and when it enters the stomach, it does not remain sufficiently long to be acted upon by the gastric juices. By the peristaltic contractions pointed out above, it is forced into the duodenum too early, and as a result of not being properly acted upon by the acid gastric juices and reaching an alkaline medium in the duodenum too soon, protein digestion is hindered. Consequently, the end products of protein digestion are present, throwing extra work on both the kidneys and liver, which are not able to take care of it. Finally these same *end products* of protein digestion are reabsorbed into the circulation, producing a long chain of ill results, prominent among which is—intestinal intoxication.

Major W. B. Allen, Medical Corps United States Army, conducted a very interesting series of experiments which he related to the writer as follows: A few years ago a company of men under his direct supervision, partaking of the regular United States Army ration, were instructed to bolt their meats, Major Allen taking careful record of the condition of the health of the company before beginning his investigation. He very carefully watched this company during a period of twelve months, having them bolt their meat during this period of time. As a result he found that this company of men had fewer sick calls than any other company in the regiment. They were more free from bowel disorders, constipation, headache and digestive disturbances than any other company of men in the battalion, which he attributed to the fact that they did not chew their meats to an unnecessary fineness. This observation is peculiarly interesting and of value in emphasizing the foolish fallacy of Fletcher's fad.

It is a mistaken idea that the proper hygiene of eating means "giving up all the things that taste good." It may be true that in many cases sacrifices are made in reforming one's diet, but these sacrifices should not decrease the enjoyment of food. It is a well-known physiological fact that it is extremely unhygienic to eat foods that are not relished. Foods must have a pleasing taste and flavor and must be enjoyed in order to be most readily assimilated. Experiments already quoted by Pavlov show that the taste and enjoyment of food stimulate the flow of the various digestive juices.

THE DRINKING OF WATER WITH MEALS

A moderate amount of drinking water during meals is not objectionable. One or two glassfuls may be taken with impunity, provided it is not taken when food is in the mouth and used for washing it down. A

moderate amount of liquid, from 250 to 500 c.c., may be taken without harm at each meal by persons in good health, and if there be a tendency to accumulation of mucus or lack of sufficient secretion, digestion may occur more rapidly when liquid is used. Physiologists estimate that the stomach contents one hour after a meal should approximately consist of 50 per cent water that can be removed by filtration.

Hawk(11) has shown that, when water drinking accompanies the taking of food, the passage of water is delayed somewhat. His experiments also show that the equivalents of from one-half to three-quarters of the amount of water ingested during a meal, if this amount is large, may be voided in the urine within 45 to 90 minutes thereafter. That the food elements were not thereby washed through the stomach into the intestine was shown by Cohnheim(12). Along the smaller curvature there is formed a trough connecting the *antrum pylori* with the cardiac opening, and through this water flows past the bolus of food lying in the stomach without washing any of the exterior away. Even when digestion is at its height, and when gastric juice is being secreted in large quantities, almost neutral water is often found leaving the stomach. Cohnheim also states that there is no dilution of the stomach contents by liquid food, and the accurate regulation of the pyloric sphincter is not disturbed whether water is taken with the meal or not.

From this brief review of the facts regarding the drinking of water with meals, we may say:

a. The ingestion of moderate amounts of water with meals not only does not inhibit the normal flow of digestive juices, but acts as an excitant to their flow.

b. The digestive juices are not rendered less efficient by dilution, but on the contrary, the greater the dilution, the more complete is the enzyme action within limits.

c. Even if the food were washed into the intestine more rapidly than usual, contrary to Cohnheim's belief, the greater efficiency and the greater amount of the digestive juices would outbalance this.

PERSONAL IDIOSYNCRASIES

In advising proper, well-balanced dietaries, personal idiosyncrasies must be taken into account, and the old adage, "what is one man's meat is another man's poison," must be respected. Again individuals have a mistaken idea of their personal idiosyncrasies; many people asseverate that nuts do not agree with them, when the trouble really is in the want of proper mastication.

In the succeeding chapters directions will be given to help the physician in prescribing a well-balanced dietary, both in health and disease, but it will be difficult to formulate any rule which will completely insure such a choice. Even the wisest physiologist cannot depend altogether on his knowledge of food values.

Sound sleep depends somewhat upon previous fatigue. So good appetite, even the zest for some particular food, follows incipient starvation. Thus while the anabolic processes are normally nearly always the same, so as to supply material for oxidation and repair of waste as needed, occasional periods of moderate shortage do no harm but rather stimulate organic vigor and economy.

ORDER AND FREQUENCY OF MEALS

The ingestion of food and drink should be intermittent, since they are intended to provide reserve force for the body. The supply and consumption of nutrients should balance, well-nigh approximately weekly or daily, except where it is advisable to remove an excess or supply a deficiency. It is even deemed advisable to have the separate meals correspond as nearly as possible to the demands for supplying food for succeeding periods.

Individuals in normal health should have three meals daily, and so should patients suffering from most chronic affections, when a sufficient amount of food can be taken at three meals for proper nutrition. In *diseased conditions,* however, it will be seen, as outlined in Volume III, Chapter I, that five or six meals are more desirable and much more readily digested, and, in rare cases of ulcer of the stomach, or pernicious anemia with persistent vomiting, food in minute quantities must be given as often as every fifteen or twenty minutes.

Persons engaged in heavy manual labor, as on a farm or in a lumber camp or in railway construction, require a hearty breakfast, a solid midday dinner served hot and a light supper or evening meal. Individuals engaged in this class of labor require(13):

1. Protein: 90 to 110 grams, 50 per cent to be from animal food; or 110 to 130 grams if only one-third of the protein comes from animal food.

2. Fat: 60 to 80 grams if the food contains 500 to 550 grams carbohydrates; or 80 to 100 grams if the food contains only 450 to 500 grams carbohydrates.

3. The heat content of the food should be 2,900 to 3,300 calories. No fixed form should be prescribed for the food taken, because persons differ so much from one another in their capacity to assimilate certain foods, in

their physical condition, etc. The lower figures given in the foregoing should be considered as the minimum, while the higher values are sufficient for the energy expenditures of strong and healthy persons engaged in moderately active muscular work.

For this class of workers the breakfast and dinner should be the largest meals. The supper or evening meal, on the other hand, should be light and easily digested, consisting of bread and milk, or other cereal food with milk, eggs and fruit, so that the stimulation of metabolic products would not interfere with sleep, and thus no great demand for innervation might be made on the nervous centers. In outlining the dietary for this class, special attention should be given to this evening meal for the reason that a full bladder and especially one filled with urine rich in waste products and of high acidity, will interfere with sleep, and should be carefully considered.

Individuals engaged in *skilled labor* not involving great physical or mental fatigue and lasting only eight hours do not demand the hearty, warm noon dinner required by the individual engaged in heavy manual labor, although both breakfast and luncheon should be richer in carbohydrates and fats than those of the professional and business man. Whether the evening meal is called supper or dinner, it should be essentially a dinner, served hot and relatively more hearty than that of the strictly manual laborer.

Individuals engaged in *professional vocations,* rising later in the morning and going to bed later in the evening, should partake of a light breakfast consisting largely of fruits and cereals and not over 500 to 700 calories. They should partake of a slightly heartier luncheon and have their principal meal at the close of the day's work, allowing four or five hours for its digestion before retiring.

Individuals in the busy marts of *commercial* life, whose work is quite equally divided between the morning and afternoon, and whose social life is relatively simple, should, if possible, take the leisure for a warm noon meal, with a sumptuous dinner in the early evening. They require a dietary that will yield from 2,800 to 3,000 calories daily.

For persons who lead a *life of leisure,* keeping late hours at night, the most convenient arrangement is a light breakfast of fruit, cereals, possibly an egg with coffee; a light luncheon about midday; and a dinner at five p. m., with a light supper, not too unwholesome and with very little stimulating beverage, containing either xanthin or alcohol, at eleven or twelve in the evening.

Night workers usually go to bed as soon as possible after finishing

their allotted task. Manual laborers working at night require the same arrangement of meals, at opposite hours, as day laborers. Business or professional night workers usually begin and close their work at relatively earlier hours in the evening and morning than corresponding day workers in the morning and afternoon, respectively; consequently, they have more time before luncheon, after completing their sleep, than day workers have before breakfast, and they can very well use the ordinary luncheon and dinner and take a light supper towards the close of the night's work.

Heretofore it has been taught that a full stomach is a protection against prolonged physical and mental fatigue, exposure to cold, dampness and infection. This is true in the sense that the increased demand for nutriment should be met by hearty meals, even at unusual hours; but it is a dangerous fallacy, if construed as an indication for overeating or for eating at too short intervals. Coffee, tea and chocolate have their greatest value and alcoholic beverages their greatest danger in meeting such emergencies. In Volume I, Chapter XVI, we have already taken occasion to point out the danger, in particular, of drinking spirituous liquors before going out into the cold.

REGULARITY OF MEALS

It is an indisputable fact that regularity in partaking of meals is advantageous, but it is not necessary to make oneself a slave to the clock by insisting on minute punctuality for mealtime. It is not wise to eat heartily simply because it is mealtime, in the absence of appetite; neither is it advisable for a person in normal health to skip a meal unless there is some derangement of the digestive organs. Variety in diet is an important factor in stimulating the appetite and digestive secretions. Variety, however, does not necessitate the use of imported or expensive foodstuffs. A reasonable degree of uniformity in diet in the organic nutrients or even in the groups of foodstuffs, fats, proteins, carbohydrates, etc., should be followed, but the different varieties of bread and crackers, meats, fruits, etc., should be freely used with different methods of cooking and flavoring. The benefit ascribed to the change of climate and scene is often due to a change of food and cooking. Frequently perfectly wholesome and even expensive and well-cooked foods fail to fulfill their function, simply for want of ingenuity on the part of the cook to afford variety and pleasing flavor.

It is regrettable that an absurd custom has been inaugurated in America of omitting breakfast, or of taking only coffee and a roll. This habit was introduced by Americans who had traveled in France, where this absurd custom exists.

SLEEP AND DIGESTION

The young *infant* should spend the greater part of his time in sleep, awakening only to take nourishment and remaining awake but a short period of time necessary for exercise. During the second and third years, the child requires about fourteen hours' sleep, gradually reduced to twelve by the eighth or tenth year and to ten hours at the close of adolescence. For detailed information pertaining to diet and sleep at different ages and physiological periods, the reader is referred to Volume II, Chapter XI.

During active *adult* life the amount of sleep depends to some extent upon heredity and bodily vigor, but largely on the severity of mental and physical activity; it is greatest in youth and least in old age. The overworked medical student requires more sleep than most other professional students, or than the average college student. For severe mental and manual labor, ten hours' sleep are usually required. Light physical labor, routine clerical work and easy professional occupations require only seven or eight hours' sleep.

Sleep favors digestion and allows time for its chemical process to be completed before the next meal, so that appetite is awakened. Therefore, from a physiological point of view, the proper time for the largest meal for farmers and mechanics is in the early part of the day, because a hearty supper ingested the evening before is out of the stomach by midnight and the digestive organs have had eight hours' rest before 8 a. m., when the logical time for a hearty meal occurs. Farmers and those engaged in manual labor, mechanics and others, are accustomed to have a very heavy, substantial breakfast.

It is a fact well known that eating a heavy meal brings about a degree of hebetude by diverting the blood from the brain to the stomach, and therefore, one should not retire until two or three hours after eating a hearty dinner. If an individual retires four or five hours after dinner, he will be able to get along very well with six or seven hours' sleep, but if he goes to bed immediately after a hearty meal, he usually requires from eight to ten hours' sleep.

The metabolic processes of the body are least active during quiet, deep sleep. During sleep the body rests, which is often quite as necessary for healthy digestion as sleep itself; indeed, the great tax upon the digestive organs for metabolizing the full meal is little appreciated, judging from the strenuous physical and mental stunts performed by some people immediately after eating. We all realize that sound sleep often dissipates indigestion. For the performance of the proper physiological functions of

the digestive organs much blood is required, which is not usually compatible with full functional activity either of the brain or the muscles. Physicians have found that, for this reason, a brief rest after each meal contributes largely to its digestion. Pavlov and other physiologists have proven beyond doubt, by producing artificial fistulas in the various organs of animals, that an enormous amount of blood is directed from the periphery of the body to the digestive organs, and that the respective digestive juices are secreted in greater abundance and with greater rapidity during the normal digestive process. From habit, the system becomes accustomed to fairly active physical exertion and even to engrossing mental activity after a moderate meal. Yet for one's well-being it is advisable to eat two or three hours before any exceptional strenuous physical exertion or difficult mental application is undertaken and to rest or even take a nap after a hearty meal, and not to eat too heartily just before retiring.

OCCUPATION AND DIGESTION

We had occasion in the early part of this chapter to refer to *work* as stimulating appetite and digestion. It is known that agreeable occupation stimulates ambition, creates the healthy habit of thinking and study, and leads to optimism which in turn promotes good digestion. We all know that the worst dyspeptics are the disgruntled and pessimistic individuals who have nothing to do but to eternally bore their friends by outlining their ills. Many of this class do not work because some relative's *will* left them in affluence. Some of these affluent individuals spend their time with sports, while others, devoid of all sporting proclivities, readily develop dyspepsia, hypochondria and melancholia. The former would be far healthier and happier if a part of their time were occupied in some useful vocation; others follow no vocation because the compensation is inadequate or their services are not sought, or they fail to find the kind of work for which they are best adapted. It is apparent to the thinking physician that psychical and dietetic treatment for this class of patients is far preferable to the customary wholesale administration of dyspeptic and nervine remedies which not only do no good, but, beyond doubt, are harmful by their chemical action in the system.

VARIETY IN DIET

Monotony in diet does not augment appetite nor facilitate digestion. This is emphasized by Barr in his published results on the monotonous

feeding of prisoners. He says the continued serving of one kind of food in one way causes loss of appetite, vomiting, flatulence, diarrhea or obstinate constipation. The great Shakespere said: "Let good digestion wait on appetite and health on both."

It is a mistaken idea to bring up children without teaching and training them to eat all kinds of foods. It is likewise a mistake to say that a boy or girl at puberty, or an individual in adult life or even old age, is too old to acquire a liking or appetite for a particular kind of food that he has never tasted, or even a food that he became disgusted with years before, perhaps because of partaking too freely of it.

We have already had occasion to point out the reasons for variety in diet. We wish to emphasize them again: First, to make it possible for individuals to live in any part of the world; second, to enable them to have a greater variety of food which permits of a better balanced ration; third, to inculcate the habit of eating different foods in youth; fourth, to enable them to enjoy meals while traveling and sight-seeing; fifth, to enhance their chance to recover from illness by being able to partake of a greater variety of nourishment. Older persons should be persuaded to cultivate an appetite for all kinds of wholesome food and not be content with one method of preparation. They should familiarize themselves with different methods of cookery, as the greater the variety, the better the appetite, and the more monotonous the fare, the poorer the appetite.

An elaborate dinner usually consists of a double meal, the soups and entrées coming first, the "good things" last. The first dessert is represented by compôtes, sherbet, etc. Such meals are usually too elaborate and often represent an entire day's ration. "Good things" are on the whole richer in caloric value than the plainer or substantial foods. An ice cream soda or sundae (sondhi) contains from 200 to 400 calories; a half pound of candy, about 900 calories; a half pint of unshelled peanuts or almonds, 900 calories. Either of the latter also furnishes about 20 grams of protein, a third of a day's ration. The intelligent laity and even physicians fail to realize that allowance should be made for such indulgence in the ration for the regular meals.

There is probably much truth in the belief that normal appetite forms a reasonable index of the dietetic needs for metabolism. If individuals free from digestive disturbances maintain a practically constant weight and a slight surplus of energy in a form of *panniculus adiposus,* without being too stout or too thin, it is not unreasonable to believe that their dietetic habits are not far removed from the metabolic needs of their bodies.

In this chapter we have endeavored to point out the necessity for the use of proper quality and quantity of food needs, and the absolute necessity of supplementing these by other accessory adjuncts to good digestion, in order to secure the best results.

We pointed out in the preceding chapter, Analyses and Cooking of Foods, the reason for proper attention to the culinary art as well as the reason for the selection of proper variety, quality and quantity of foodstuffs. The illustrative tables on analyses of foods in Volume I, Chapter XIX, are very extensive and complete, giving the protein, fat, carbohydrate, ash, fiber and water content of every known article of food. These tables also show the caloric value per pound and per portion, so arranged that the physician or dietitian can, with ease and rapidity, prescribe a variety of diet either in health or for certain diseased conditions, and can at a glance know the caloric content of the ration.

In the ensuing chapters of this work, the scientific application of trophotherapy to the general principles of nutrition both in health and in diseased conditions will be gone into very exhaustively. The reasons for subjecting patients suffering from various diseases to a strict dietetic therapy will be taken up, and the science of sitology, particularly as to the therapeutic value of foods in disease, explained. The apparent sameness of diet in many affections is not real, as will be seen in the large number of foods allowed containing protein, carbohydrates and fat. The percentage of each element allowed in every case is not stated, because it must vary with the patient and can be safely left for the physician to prescribe after he has familiarized himself with food values and has studied the case.

RELATION OF MEDICATION TO MEALS

Before closing this chapter, the author deems it advisable to refer to the relation of medication to meals. The directions and rules incorporated herewith for prescribing certain medicines before meals, certain other medicines immediately after meals, and others one or two hours after meals, are based almost entirely on the writings of Dr. A. L. Benedict(1).

Ordinarily, acids should be given before meals, especially when given to promote secretion of hydrochloric acid. It is well to bear in mind that half an hour should be allowed for their passage into the intestines before the meal is begun. If alkalies are used to reduce gastric acidity, they should be given one hour or more after the ingestion of the meal, and in some instances they should be repeated in divided doses. Alkalies when

given for this purpose should be prescribed in the form of carbonates. Some clinicians make a common error of regarding neutral salts of alkaline metals as alkalies. When there is a deficiency of hydrochloric acidity, hydrochloric acid should seldom be given less than an hour after meals, in order to permit the stomach to do what it can in this direction and sometimes acids are needed in several divided doses given at intervals of half an hour. It should be borne in mind that acids must not be given after the stomach has emptied itself. The practice of prescribing hydrochloric acid before meals to reduce hypochlorhydria is useless.

Simple bitters and other remedies used to spur on a flagging appetite or to stimulate gastric secretion should be given shortly before meals. Drugs which exert local irritant action, unless for some special reason, should be given during or after a meal in order to secure dilution and thorough admixture with the stomach contents. Drugs intended to exert a local action on the stomach, as bismuth, emulsions of bismuth, etc., should be given three or four hours after a meal and the interval between meals should be lengthened as much as possible to allow sufficient time for their action. Drugs which exert a nauseating action should be given on a full stomach immediately after a meal, provided the physician desires to prevent their nauseating effect; otherwise they should be given on an empty stomach. Remedies intended to exert their action mainly on the intestinal tract should be given about three hours after a meal, and in capsule form if they are decomposed by the gastric juice. Ordinarily, gelatin capsules do not dissolve within an hour, but salol or keratin coatings may be employed for pancreatin, etc. Many substances, such as salol, salacetol, iodipin, etc., are not acted upon in any degree in the stomach and hence may be given immediately after a meal.

Saline cathartics and purgative mineral waters usually act more energetically if taken half an hour or so before breakfast or before other meals, and may fail if given at night when the patient is about to retire. Other cathartics intended to act from a single dose are best given just before retiring. Laxatives when used regularly are usually given in small dosage, preferably with meals, whether before or after being a matter of indifference, unless their administration before meals should hinder appetite. Under such circumstances they should be given after meals.

Corrosive medicines of all kinds, including the mineral acids and salts, should be well diluted and drunk through a tube, or the tongue should be used as a trough and the mouth should be immediately rinsed in either case, preferably with a dilute alkaline solution of soda or borax.

Quinine and other bitter drugs may be given with chocolate to dis-

guise the taste. Jam, apple sauce, etc., may be used to disguise the taste of some medicines.

The iodids and salicylates may be given in milk. The iron salts should be preferably administered in sirups, never in mucilages, both to disguise the taste and prevent corrosion. Castor oil may be given in whiskey, milk or fruit juices or after salt has been placed on the tongue.

Since the digestion of fats and oils takes place only after saponification, cod liver oil should not be given until one and a half hours after meals.

The food and digestive juices contain various substances more or less incompatible with certain medicines; for example, starch with iodin, hydrochloric acid with calomel, hydrochloric acid, proteins and mucin with silver salts; tannin with alkaloids, iron and various other substances, and gummy substances with iron. To what degree these incompatibilities are of consequence, or how far they can be avoided, must be considered in each case, and for further information pertaining to these incompatibilities, the reader is referred to the various text-books on Materia Medica and Therapeutics.

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CHAPTER V

VARIOUS FACTORS BEARING ON DIET, DIGESTION AND ASSIMILATION

IN COLLABORATION WITH

A. L. BENEDICT, A.M., M.D., F.A.C.P.

The universe is naught but by life, and all that lives is nourished.

Transmutability and Reservation of Foods.
Waste and Digestibility of Foodstuffs.
Substitutes for Food.
Starvation and Inanition: Starvation; Inanition.
Fasting: Fasting in Religion; No-Breakfast Plan; Fasting as a Cure; Long-continued Undernutrition; Fasting Experiments; Effect of Fasting on Metabolism.
Perversion of Appetite: Parorexia, Anorexia, Bulimia, Polyphagia, Akoria, Polydipsia, Rumination, Merycism, Vomiting, Hiccough, Aërophagia, Seasickness.

TRANSMUTABILITY AND RESERVATION OF FOODS

From a careful study of the elements of foods, it is evident that one kind of food cannot be transmuted into a totally different kind. While we know that one saline may, to a slight degree, replace another in osmotic phenomena, and that even hydrochloric acid may be replaced by other strong acids in gastric digestion, yet sodium cannot entirely take the place of potassium, nor is it possible, because of its greater toxicity, for potassium to supplant sodium to any great degree. The calcium salts, being insoluble, are peculiarly adapted to the growth and development of the skeleton, and while magnesium salts are more or less associated with the calcium salts, they cannot be substituted for each other to any great extent. It is unnecessary to repeat similar citations for the various inorganic constituents of the body. This and the following paragraph are based largely on Chapter VI of Benedict's "Golden Rules of Dietetics" (Mosby Co.).

When the various essential foodstuffs are administered in sufficient amount to furnish the requisite calories, and in a condition available for absorption and assimilation, it does not matter particularly in just what natural combinations they are employed. It is possible, though not always advisable, to replace water by substituting quantities of the various beverages and semisolid or solid foods containing it. During a twenty-four-hour period about 200 c.c. of water is evolved in the system from the oxidation of hydrogen in organic combination, especially from the carbohydrates, but also, to some extent, from fats and proteins. Therefore we may safely assert that no one natural foodstuff or group of foodstuffs is indispensable, or even particularly requisite for good nutrition, with perhaps the exception of milk in the case of infants. It is admitted that one may live on a strict vegetable diet for a protracted, if not for an indefinite, period, yet the entire absence of animal proteins is not conducive to a perfect state of health. Practically there is no essential difference between animal and vegetable protein, yet there seems to be a something in animal protein that is not supplied by vegetable protein. Physiologists have been able to note that different individuals seem to reach their optimum on different proportions of animal and vegetable protein, and even on different proportionate uses of different groups of flesh, as that of quadrupeds, fish and fowl, or of different species of meat, as beef, mutton, pork, etc.

Theoretically, it is possible, and even practical, to replace the hydrocarbons with proteins and carbohydrates, without serious detriment to the human organism, as obviously no one particular kind of fat, as olein, palmitin or stearin, is indispensable; besides, these different varieties appear to serve a similar purpose, with the exception of stearin, which requires relatively more to replace the others progressively. So to a considerable extent the precise chemical nature of the deposited fat of an animal depends largely upon its diet, which may even be modified by artificial limitation. For instance, the fat of a hog, fed on corn and meal, will be white, firm and quite different from that of a hog fattened on slops and swill, so it is not improbable that the diet is relatively of great importance, and it is not at all unlikely that the yellow color of human fat is due, in part, to the large consumption of flesh and butter and a variety of natural pigments occurring in foodstuffs. The difference in the caloric value of the various varieties of fats and of carbohydrates is slight, scarcely sufficient to warrant the exact studies of calorimetry, owing to the preponderance of many sources of error.

We learned when studying the proximate principles of foods in Vol-

ume I, Chapter III, that all assimilable carbohydrates are ultimately broken down into simple hexoses, and more often into dextrose. During the first year of life the child uses lactose almost entirely, though it can digest a small amount of starches during early infancy (1). Later in life the individual appetites for starches and sugars respectively are markedly different; therefore, it is extremely difficult to state just how far these are physiologically interchangeable, and especially to calculate the exact available energy of any one sugar in the process of nutrition. Practical experience coupled with animal experimentation emphasizes the fact that the various sugars do not furnish desirable substitutes for starch. The reasons for the non-transmutability of sugars and starches are (*a*) that the former when ingested in large quantities produce irritation of the mucous membrane, (*b*) cause fermentation, (*c*) and by overtaxing the glycogenic function of the liver allow a leakage of sugar into the circulation. (*d*) Besides there may possibly be other abstruse reasons.

Experience confirms the fact that individuals who partake freely of cereals, potatoes, breadstuffs, etc., crave little sugar and *vice versa,* while the individual appetite for carbohydrates generally is inverse to that for hydrocarbons and proteins respectively and together, and that appetite for all food varies with the individual and with the season. The craving for sugar is not always due to a luxurious habit, though it may depend upon a relative, but still not an abnormal, weakness of digestive ferments, or even upon abnormalities of the intestinal canal. The consumption of sugar has increased considerably during the past two or three decades, commensurate with the growth of the cane and sugar beet industries (*see* Volume I, Chapter XVII, Sugar, Spices and Condiments), also with the increasing magnitude of the culinary and confectioner's art. Benedict says, "An individual in normal health may ingest with impunity 100 grams a day of carbohydrates in the form of sugar, while certain persons may take double this quantity without harm."

Hydrocarbons are theoretically replaceable by other organic foods and even absolute fat-free diets may be allowed without harm, but the same statement cannot be made for carbohydrates. It is a known physiological impossibility for the system to digest and absorb more than a given definite maximum of fats, and 80 grams of carbohydrate are required to prevent catabolic disturbances. We know that a too liberal allowance of meats induces an inevitable increase of nitrogenous waste products from the vicarious use of proteins.

Proteins, unlike carbohydrates and hydrocarbons, are employed, not

only to furnish heat and energy, but to replace wear and tear of the tissues. They are positively non-replaceable, beyond a certain percentage, by either carbohydrates or fats, or even non-protein nitrogenous substances, such as gelatin and purins, free or combined. However, it should be borne in mind that beyond the minimum of 60 to 100 grams a day (the precise standard being an unsettled question), proteins should be replaced by carbohydrates and hydrocarbons, provided, of course, there is no metabolic disturbance such as diabetes and obesity. We know that within the system both the protein and carbohydrates may be transmuted into fat and so deposited. Physiology definitely proves that dextrose and glycogen may be formed from fat or protein, and possibly from both. There is a popular idea that much energy may be accumulated by the excessive ingestion of foods, which is partially true, but the importance of this notion lies in the fact that it leads to overeating.

Deposited fat is the only evidence that a reserve energy of any importance is accumulated. The human body may put on 100 pounds of fat, or over 400,000 calories in potential energy, or the requisite amount to sustain the body for 200 days. Such a demand rarely happens in civilized life, and if so the body certainly would lack the power to utilize it, even with concomitant waste of protein tissue. There is no recorded case where the body reserve energy has lasted more than about forty days without a supply of organic nutriment from without.

Carbohydrates may be stored in the body as dextrose in solution, and as glycogen in muscular tissue and gland cells, particularly in the liver, to the extent of 300 grams per day, just barely enough to supply a half day's caloric demands for the regulative functions.

In studying Protein and Nutrition (*see* Volume II, Chapter VII), the researches of Chittenden, Fischer and others give proof that a small amount of protein in excess of the daily requirement for needed calories may be stored. Voit and other investigators, experimenting with dogs, conclude that the proportionate storage is between 5 and 8.5 per cent. Von Noorden(2) estimates that the human being can store about 10 per cent of the excess protein. So we may safely conclude that the energy eliminated from metabolized protein will aggregate about 90 per cent, and the stored protein will be in the neighborhood of 10 per cent of the amount ingested. In addition, it must be remembered that a small moiety of reserve protein occurs in the circulatory and lymphatic systems, while the remainder is stored in hypertrophic or in newly formed cells. So much protein is required to supply the wear and tear of normal mus-

cular tissues that only a very small amount can be stored as a reserve available in starvation or relative inanition.

From the foregoing we may arrive at the following conclusions:

(*a*) It is useless to increase the protein ration to create a reserve of force and tissue material, since such a course overtaxes the organs of excretion and increases the chances of auto-intoxication.

(*b*) It is not, at present, an accepted fact that only the protein minimum—just enough to balance the nitrogen equilibrium—is the ideal ration. The proper nutrients for a normal body amount to at least three meals a day of a standard dietary. (Volume II, Chapter VII.)

(*c*) The storage of hydrocarbons in persons of small stature should not exceed the caloric requirements for a forty-day fast—about 12 pounds for a man weighing 140 pounds; a man of full stature should not carry more than 34 pounds of fat.

(*d*) It is comparatively easy by superalimentation to increase body weight from one-half to one pound per day by depositing fat. Benedict believes that in the entire absence of food, even on exposure to cold or at strenuous muscular exertion, the body cannot utilize more than one-half pound of fat daily, and, while greater loss may occur in sickness, the physiological reduction of weight on a low diet will equal the rate at which fat can be deposited.

WASTE AND DIGESTIBILITY OF FOODSTUFFS

Benedict, who has studied this subject from every viewpoint, holds that the waste of foodstuffs occurs both economically and physiologically. First, the loss in transportation to the retail market; second, the loss in preparing and serving, besides the financial loss in using, often through ignorance, expensive nutrients of a lower protein or caloric value than cheaper foods. Again in the trimming and paring of foods, the cook often wastes large quantities and finally at the table the waste is considerable, when the serving is larger than is eaten, and must be borne in mind in all cases when computing nutrients from a caloric viewpoint.

In the average well-to-do American family, the percentage of waste

of digestible and assimilable foods in the kitchen and at the dining table ranges from 10 to 50 per cent. Gross waste is often due to ignorance on the part of the cook and other servants. On the other hand, the removal of fat, skin, seed pods, husks, cores and other indigestible portions of food material cannot be considered as waste, but both economically and physiologically the theoretic high food-value of fat meats must be discounted, because of the ultimate rejection of fat.

Physiologically, food waste can be accounted for, first, by the excessive ingestion of one or more kinds of organic nutriments, and, second, by the swallowing of foods which have been imperfectly comminuted. Vegetable foods swallowed whole, such as beans, peas, corn, huckleberries, etc., largely escape digestion, because their skins or husks, composed largely of cellulose matter, are not broken up. Likewise starchy vegetables, meats, eggs, etc., swallowed without proper mastication are wasted to a large degree. When milk is gulped down like water, it forms large curds, much of which is passed away unchanged. Alimentary saprophytosis is a possible aid in the digestion of certain food materials—especially vegetable foods containing cellulose material. The efficiency of the various enzymes and hormones exerts an obvious influence on the amount of alimentary waste; even when mastication is well performed and intestinal saprophytosis is within normal limits, there is considerable loss of food material. Atkinson calculates the utilization of some of the staple foods as follows:

THE UTILIZATION OF SOME OF THE STAPLE FOODSTUFFS

Meat and fish..	nearly 100% of protein,	79–92% of fat	
Eggs..........	" 100% " "	96% " "	
Milk..........	88–100% " "	93–98% " "	doubtful of carbohydrate
Butter........		98% " "	
Oleomargarine..		96% " "	
Wheat bread...	81–100% " "	(too little fat to estimate)	99% carbohydrate
Corn meal.....	89% " "	" " " " "	97% "
Rice..........	84% " "	" " " " "	99% "
Peas..........	86% " "	" " " " "	96% "
Potatoes.......	74% " "	" " " " "	92% "
Beets.........	72% " "	" " " " "	82% "

The experiments of Leo Breisacher call attention to the loss of albumin, as ranging from 2.9 per cent to 4.9 per cent on a milk and cheese diet, and 6.5 per cent, 7 to 7.1 per cent on milk alone. For loss on other diets consult the following tables from Breisacher, referred to by Benedict:

Percentage of Unabsorbed Albumin (Breisacher)

Corn meal	15.5%	Peas and bread	12.2%	Wheat bread	19.9%
Rice	20.4%	Rye bread	22.2%	Wheat bread	18.7%
Peas, cooked soft	17.5%	Black bread	32. %	Potatoes	32.2%
Peas, cooked	27.8%	Lentils	40. %	Potatoes, lentils and bread	53.5%

Percentage of Unabsorbed Fat (Breisacher)

Olive oil	(liquid at ordinary temperatures)	2.3%
Butter	(melting point 31° C)	1.28–6%
Lard	" " 34° C.	2.5%
Tallow	" " 49° C.	7.4%
Stearin	" " 60° C.	86–91% unabsorbed

The excretion of fat in the stools varies with the conditions under which it is ingested. During fasting there is a daily loss in the stools of somewhat more than one gram of fat. When the quantity ingested is from 25 to 40 grams, the loss varies from 10 to 15 per cent, *i.e.,* about 4 grams. When the quantity ingested is increased to 100 grams, the gross loss remains practically the same. The reduction in percentage may reach a point as low as 1.25 per cent. The explanation of this discrepancy is found in the fact that when very little fat is eaten, it consists chiefly of beef, mutton or other meat fat, and of vegetable fat which is embedded in the cellulose. The loss of fat when small quantities are taken averages about the same as the loss during fasting, about 1 gram daily. When the daily quantity of fat exceeds 150 grams, the loss increases in proportion and may reach 20 per cent. This high rate of loss is most apt to occur when oils having a direct laxative action are administered. With a coarse vegetable diet, the loss of all nutrients increases progressively. This effect is partly due to the laxative action of the so-called coarse vegetables.

From these data it appears that the finer the subdivision of the food ingested, the larger will be the proportion of nutrients assimilated. For example, in the case of bread made from decorticated whole wheat meal, about 69 per cent of its protein and 92 per cent of its carbohydrates are utilized, while fine white bread made from bolted flour yields 81 per cent of its protein and nearly 100 per cent of its carbohydrates. Potatoes offer another interesting example: As ordinarily cooked and masticated, this vegetable yields about 70 per cent of its protein and 92 per cent of its carbohydrates to nearly 100 per cent. The class of coarse vegetables, including turnips, carrots, beets and cabbage after thorough cooking yield protein in the proportion of from 60 to 80 per cent, and

from 80 to 85 per cent of carbohydrates. On the other hand, if these vegetables are not thoroughly cooked and well masticated, and if in addition they are habitually used and in generous quantities, their excretion may ultimately exceed their utilization.

It has been estimated by Rubner that on an ordinary mixed diet the nutrient waste amounts to about 8 per cent of the total calories, and we may safely conclude, therefore, that from 200 to 300 calories of the standard ration may be considered as a physiological waste—by failure of digestion. This waste is taken into consideration when estimating the required calories which are stated in terms of ingested food. Therefore this variation is not of importance, and the physiological waste of nutrients need not be given any consideration. Variations in food waste may possibly explain the fact that, say, two persons of the same weight and following the same vocation may require different amounts of food to maintain normal weight and health. The fecal excretion from a normal person averages from 100 grams per day moist weight upward, and on analysis will be found to contain 20 per cent of fat and 7 per cent of albumin, estimated by multiplying the nitrogen by 6.25. In wasting diseases, it is considered practical to try to determine the amount of waste of nutrients in the alimentary canal, but the difficulty and expense usually prevent such determinations. Still something may be accomplished by ordinary chemical tests and by macroscopic and microscopic examination within the abilities of the clinician.

Contrary to popular belief, it is quite difficult to give an intelligent opinion concerning a general comparison of foodstuffs as regards their digestibility. A few inorganic ingredients of the diet—such as water and salines—require no digestion. Benedict, who has studied this subject very carefully and exhaustively, holds that we have no precise enlightenment concerning the relative digestibility of hemoglobin, nucleins, lecithin, organic combinations of iodin as in the thyroid. Carbohydrates and proteins undergo many changes before final absorption. For instance, cooked starch is partially digested, both mechanically and chemically; dextrin, as in bread crust, is still further digested; the double hexoses, as cane sugar, maltose—a stage of digestion beyond colorless dextrin—and lactose require inversion into single hexoses, and of the latter dextrose is the ultimate one ready for oxidation, while levulose and galactose must be changed into dextrose. The hydrocarbons split into glycerol and fatty acids; the former, uniting with water, forms glycerin, and the latter joins with alkaline bases and forms soaps, yet it does not appear that either glycerin or soaps can in any particular be considered as nutrients.

There is still considerable uncertainty as to the digestion of fats. Atwater estimates that 95 per cent of fat of all animals is absorbed, and only 90 per cent of the fat of vegetables. Rubner declares that only 80 per cent of the fat from beef and mutton is absorbed. Butter is fairly well absorbed, while bacon fat is not so well absorbed, because it is enclosed in cells, and from 7.5 to 17.4 per cent escapes absorption. It is safe to assert that the lower the melting point of fat the greater will be the percentage of absorption. It has been found that about $5\frac{1}{2}$ ounces can be absorbed without any loss being detected on examination of the fecal excreta.

It is held that the coagulation of *protein* is a preliminary step in the process of digestion. Benedict holds that there may be some good grounds for the old theory that this stage in protein digestion acts as a safeguard against excessive protein nourishment, though of course he realizes that it is not a safeguard against the after-effects of the end products of protein digestion. Rennet coagulates the caseinogen of milk. The gastric, pancreatic and intestinal juices also coagulate caseinogen, although the pathologic instances when the former fails to coagulate milk are nearly always confined to adults, and this peculiar factor of safety is not quite well understood. There is yet some question whether there exists a separate rennet ferment or ferments, or if coagulation is really brought about by pepsin, trypsin, and the intestinal activation for tryptic digestion. A certain amount of coagulation takes place in the process of cooking of proteins which may be considered a step in digestion; but the principal aim in cooking is to kill parasites, including various bacteria, and at the same time to render the food more tasty and more readily masticated and comminuted. While artificial coagulation of milk by rennet may be considered a digestive process, yet it does not appear to aid its further digestion in the alimentary canal, and the curd if dried and reduced to a fine powder is more difficult of digestion than raw cow's milk. The digestion of proteins, artificially, has not yet been successfully accomplished. The so-called predigested protein occurs mainly as albumose, and if the process is carried further it reaches the peptone stage, making a disagreeable bitter product, actually toxic. When reduced to the amino-acid stage there is a question whether the nutritive value is lost, but this has recently been stoutly denied.

Vegetable foods containing a relatively high percentage of cellulose are indigestible, not that cellulose itself is a nutrient, but that a meshwork of cellulose incloses the starchy granules and other nutrients which escape digestion, and in this way causes considerable waste of food ma-

terial. It must not be overlooked, however, that cellulose, especially that occurring in fine, threadlike meshes, is stimulating to peristaltic action. Cartilaginous or tendinous fibrous tissue is likewise indigestible; and when muscular tissue is not cut, chopped or comminuted sufficiently, there will be considerable waste of nutriment. Many of the older physiologists worked out elaborate tables to show the length of time required for the stomach to perform its functions. W. Gilman Thompson(3) compiled a table showing the time of the average sojourn in the stomach of various food products. Modern research emphasizes the physiological fact that this is not a test of digestion itself, because gastric digestion is not complete, for the reason that the process of digestion is only begun in the stomach. In other words, the function of the stomach is only to make ready the foodstuffs for the various processes of digestion.

It is quite difficult to arrive at an accurate estimation of the digestibility of *fruits.* If they are not well masticated or otherwise comminuted there is considerable waste. When thoroughly masticated, the water and inorganic salts are ready for absorption, and the metabolism of sugars is a simple matter. Most fruits contain too little fat to be considered and there is some doubt as to the actual degree of assimilation of the protein. Bananas contain a liberal quantity of raw starch, which places them in a class by themselves, so that they cannot be digested to any appreciable extent until they have reached the duodenum and beyond.

SUBSTITUTES FOR FOOD

Substitutes for food are often necessary, especially under conditions in which, from poverty or exposure, sufficient quantities of food cannot be obtained. Under such conditions, the craving of hunger may be diminished and actual tissue-waste may be retarded by the substitution of certain mild stimulants and beverages. Tea, coffee and tobacco all possess moderate actions in this respect, and alcohol under such conditions is both a stimulant and a food. Natives in various barbarous or semicivilized countries while performing long feats of marching, being often unable to obtain sufficient food with regularity, make use of a variety of different substances as substitutes for food, among which may be mentioned betel-nut, cola-nut, Siberian fungus, the coca leaf and pepperwort, which are chewed from time to time, and hashish and opium, which are both eaten and smoked. Various forms of alcoholic fermented drinks are made use of. Various concentrated foods of high nutritive value with small bulk may be used in the place of fresh foods. Attempts have been made from

time to time by the heads of the principal armies of the world to supply a ration with concentrated elements for the use of troops on prolonged marches, but after a few days' subsistence on such a ration it has been found that the men lose weight and deteriorate in strength.

STARVATION AND INANITION

Starvation.—Starvation is a condition brought about by insufficient food for the maintenance of the body. It is of rare occurrence in civilized communities. In such extreme cases, life may be maintained up to a limit of about 40 days if there is no deprivation of water and no exposure to cold. During prolonged deprivation of food the tissues become exhausted in inverse order to their functional importance. So says Benedict in his valuable little work, "Golden Rules of Dietetics." The glycogen stored as a reserve is utilized within a few days, though sugar may subsequently be formed from protein. The hydrocarbons are exhausted at a rate varying according to circumstances and individual peculiarities, only about 1 per cent remaining. Wherever there is interference with the oxidation of fat as in certain pathological conditions, the patient dies virtually from lack of the ability to perform the various metabolic processes, while a relative excess of fat remains. The skeleton cartilages and dense fibers remain nearly in a normal condition; likewise the heart and brain during starvation are almost entirely unimpaired, while the muscles and various glands are atrophied according to the ability of the body to spare their function. If water as well as food is withheld, death will occur in from five to eight days.

The period of time during which different individuals can subsist without food depends upon:

(*a*) External conditions of temperature and moisture.

(*b*) The amount of work being performed.

(*c*) The physiological conditions of the body.

(*a*) The length of time that an individual can endure starvation is influenced by various factors. As has already been stated, exposures to cold reduce vitality and lessen resistance, so that under these conditions the period of endurance is shortened. A moist atmosphere by preventing surface evaporation helps to prolong the possible period of starvation. And finally the maintenance of a uniform temperature of the surrounding air also prolongs the period during which a man can abstain from food.

(*b*) Individuals who move along the lines of the least resistance, shunning every form of exercise, can live much longer without food than those

undergoing strenuous exercise. In time of famine, self-forgetfulness by diverting the mind from the sufferings of the body tends to prolong life.

(*c*) The full-fed, well-nourished endure longer intervals of abstinence from food than weakened invalids. The distressed mental condition attending delirium may be increased by lack of sufficient nourishment. Sex seems to exert no influence upon the effects of starvation, which are most keenly felt at the extremes of age, by young children and aged persons.

The author, while serving in the United States Marine Hospital Service, attended four sailors who had been shipwrecked and picked up at sea and brought ashore. These men, after recovery, related that when the small amount of water and food which they fortunately had, gave out, they cast lots among themselves (five in number) to determine which one of the party should die in order that the remaining four might partake of his flesh and blood for subsistence. They were the most wretched and despicable human beings imaginable.

A pathetic account of the miseries of starvation is reported in the journal of Lieutenant De Long(4). W. Gilman Thompson, in his work on "Practical Dietetics," quoting from De Long, says: "After leaving their sinking vessel, the members of the Arctic expedition were exposed, at first in open boats and later in their long sledge journey, to the most exhausting work and to intense suffering from cold and wet. They frequently dragged their sleds in severe storms for ten or twelve miles a day, while subsisting solely upon half a pound of stewed deer meat, with a little tea three times a day. This food being exhausted, they were obliged to consume the meat of their last remaining dog, which they ate fried. They subsisted upon this food exclusively for four days longer, having an allowance of but half a pound a day, and finally their last journey of twenty-five miles was performed with no other nourishment than a few ounces of alcohol and an infusion made from some old tea leaves. During this time their intense suffering from hunger was partially alleviated by chewing scraps of deer skin, which, from its bulk in the stomach, seemed to afford slight relief." De Long quotes from the physician in his Arctic expedition: "Alcohol proves of great advantage; it keeps off the craving for food, prevents gnawing at the stomach, and has kept up the strength of the men on an allowance of three ounces per day.

"The alcohol being exhausted, they lived for another day upon a teaspoonful of olive oil, with a breakfast composed of an infusion made from the Arctic willow (containing really no nourishment) and 'two old boots.' After this the men, becoming weaker and weaker, were unable to proceed

farther on their journey, being driven back by intense cold and the difficulty of crossing the partly frozen rivers. Their feebleness gradually overcame them, until one by one they died of inanition. Four men survived for sixteen days upon absolutely no food whatever, and possibly their sufferings were even further prolonged, but the journal of their gallant and heroic commander ceased at this point, for he, too, died."

Inanition.—Inanition is the inability of the tissues to assimilate food. The term should be restricted to those cases of acute starvation observed in early life. It is characterized by loss of weight due to a disordered metabolism. This condition is characterized by fever, and the malady is not infrequently mistaken for some other disease. It follows the ingestion of improper food or abstinence from food, where infants are abandoned, or other cases that are grossly neglected and starved. Gross errors in feeding are a contributing cause—where food is given which is absolutely unsuited to the needs of the child.

Individuals who are well supplied with a reserve of food stored in their tissues can resist starvation by calling upon this reserve to maintain the energy of the body in the absence of food; and, having a larger supply than thin or emaciated persons, they can withstand starvation for a much longer period, although they may complain more bitterly of the pangs of hunger than individuals previously accustomed to a scant diet.

Experiments were conducted by Chossat to determine the rapidity of the loss of body weight, etc., and it was found that starving animals, while losing 40 per cent of their body weight, lost in fat 90 per cent. "Anselmier fed starved dogs upon their own blood and succeeded in prolonging their lives for three or four days beyond the usual limit, until 60 instead of 40 per cent of their body weight had been lost." During the winter of 1776 and 1777 an accident occurred in a colliery in South Wales which resulted in the imprisonment of four men and a boy for ten days without food. When they were rescued they were alive, though very feeble, and were able to walk when released. Fortunately, a supply of water was available and the atmosphere in which they were confined was moist. A second accident occurred in this colliery and a number of men were confined in a mine for six days without food, and while their sufferings were extreme, nearly all were able to walk on being rescued. From this we may assume that the lack of food may be endured with far less torture if water is applied internally and externally. When water is withheld in such a condition, the body loses weight very rapidly, the tissues become dry, thirst excessive, the secretions suppressed, and suffering is very greatly intensified.

FASTING

Fasting is one of the most ancient religious rites of which there is any record. More than two thousand years ago the fasting cure was advocated by the school of the natural philosopher, Asclepiades(5), who also applied the "water cure." It is recorded that Plutarch said, "Instead of using medicines, rather fast a day."

Fasting in Religion.—It was practiced, as stated above, in connection with religious ceremonies and so came to be considered an inseparable part of almost all such observances. Thus we read in a queer old book, entitled "Of Good Workes, and First of Fasting"(6), that the Church of England speaks of fasting and of its treatment by the Council of Calderon as follows:

> The Fathers assembled there . . . decreed in that Council that every person, as well in his private as public fast, should continue all day without meat and drink, till the evening prayer. And whosoever did eat and drink before the evening prayer was ended should be accounted and reputed not to consider the purity of his fast. The canon teacheth so evidently how fasting was used in the primitive Church, as by words that cannot be more plainly expressed.

From the above quotation we find that fasting was considered to be a highly important part of the religious ceremony, and of spiritual salvation. We find this same idea expressed throughout the Holy Writ in passages too numerous to mention(7). The excellent work, "Vitality, Fasting and Nutrition," by Carrington (Rebman Co.), has been freely consulted and quoted in the preparation of this section.

We hardly need to be reminded that the Holy Nazarene himself fasted for forty days. Many people accept Christ's forty-day fast as sufficiently explained by his supposedly Divine Power. It was, in short, a miracle which would be impossible under ordinary circumstances for any other man. Dr. Tanner aroused the whole scientific world a few years ago by fasting forty and again forty-two days, on two separate occasions, and while charges of "fraud" were circulated at the time and believed in by many, yet no one who took possession of the facts of the case gave any credence whatever to these stories. Great as was the prejudice in professional circles, and bitter as was the feeling at the time, no direct charge of fraud could be made, for no atoms of proof of such were forthcoming. The general view of fasting is probably well summed up by the Reverend Puller(8) when, in discussing the previously mentioned cases of fasting during Lent in Jerusalem, he remarks:

Such fasting is certainly, for the mass of English people, impossible now. It seems to me that this great difference in the power of fasting, which is quite indisputable, must be taken into account, when we are considering how to apply the Apostolic rule to modern circumstances.

Victims of forced fasting and starvation become so ravenous that all sense of taste gives place to intense hunger. Muscular action is no longer possible. There is vertigo and faintness on raising the head, the voice is lost, and gradually the nervous system succumbs to languor and general prostration. Chambers records an occurrence where three men and two boys were starved for twenty-two days in an open boat. They had ten days' ration to start with, and subsequently nothing but old boots and jellyfish, and they fought violently with one another over these.

Robert de Moleme, the founder of the Cistercian brotherhood, was overcome with grief on learning of the death of a female friend, and like General Boulanger, resolved to follow her to the Land of Shades. Being averse to direct suicide, he retired to the mountain lodge of a relative friend, and abstained from food in the hope that one of his frequent fainting fits would fade into the sleep that knows no waking. But finding himself alive at the end of the seventieth day, he reconsidered his resolution and began to suspect a miraculous interposition of Providence. By resuming his meals, in half ounce installments, he contrived to recover from the condition of frightful emaciation, and in the supervision of an ever-increasing number of scattered monasteries, led an active life for the next fourteen years(9).

No-Breakfast Plan.—The American apostle of "fasting as cure for disease" was the late Dr. Dewey(10), who recommended fasting as a relief for certain disorders. That short fasts are beneficial to many people there can be no question. Such fasts have been practiced from time immemorial. Dewey was the first to urge the "no-breakfast" plan of restricting the intake of food, on the supposition that the majority of people consumed a great deal more food than was required.

This apostle says(11): "There is no necessity, after a night of undisturbed restful sleep, to partake of food; sleep is not a hunger-causing process." He deprecates the American breakfast, holding that when "we arise in the morning with our brains recharged by sleep, we should at once go to our place of business." He also says it is "a foolish expenditure of energy to take any kind of physical exercise in the early morning," holding to the view that when one has worked long enough he will become fatigued, and when this point is reached, he should have a period of rest preceding the partaking of food.

We cannot waste space in replying to his assertions. We agree, however, that moderate fasts are beneficial, but should not be instituted except under the personal observation of the family physician. Dewey's no-breakfast plan is not an ideal institution for general application. It might be suited to the Eskimo, who consumes enormous quantities of meat and oil at one sitting, or for the city dweller, who keeps late hours and partakes of midnight suppers, who is a spender and not a producer, but for the business man, a light repast to break the fast is necessary.

The Frenchman, as a rule, with the exception of his roll and cup of chocolate in the morning, partakes of but little food until midday. The Englishman consumes a rather hearty breakfast at an early morning hour, which the average American and Canadian consider meager. The two latter want meat, cereals, fruits and coffee. It is not disputed but that many people would be in better health if they had no breakfast at all, but, generally speaking, most Americans eat too much at all three meals.

An ideal breakfast for those following sedentary occupations is a fruit, a cereal, an egg or a piece of breakfast strip, a roll and a small cup of coffee. As said before, we are opposed to the no-breakfast plan, believing that the body has need for material to produce heat and energy, and abstinence from food until the middle of the day tends to draw too heavily upon the reserve store of protein and glycogen, and possibly to a limited extent upon the store of fat. The no-breakfast plan would not satisfy the wants and needs of the majority of live active individuals who lead strenuous lives, and again the no-breakfast eater is usually a complaining, scrawny, puny individual as compared with the hearty breakfast eater.

Fasting as a Cure.—It is claimed by devotees of fasting as a cure that the principle on which the hunger cure acts is one with which all physiologists are acquainted. During a fasting condition, nature makes an effort to rid the body of effete material. This the author experienced in a ten-day fast a few years ago. He was suffering from intestinal stasis with putrefaction of the alimentary contents. The end products of protein digestion were greatly disturbing the metabolic processes of the body, resulting in both mental and physical hebetude. At the suggestion of a medical confrère, the author went on a ten-day fast with no aliment except strained vegetable soup made without meat or fats. The craving for food was very strong for the first two or three days, but after this, going without the ternary food elements caused very little, if any, inconvenience or annoyance, except for the elimination of most offensive excreta, which was aided by the self-administration of Russian mineral oil.

When he returned to his former dietary habits, which were slowly and carefully resumed, there was noticeable improvement in his condition.

Temporary denutrition exercises a favorable influence in certain disorders, more particularly of the alimentary tract, such as intestinal autointoxication, intestinal stasis with putrefaction, intestinal toxemia, etc. It gives nature a chance to clean house. The organism, on a starvation dietary, soon begins to lessen the outgo of energy. The movements of the organs of respiration slow down, the temperature drops slightly below normal, the secretion of bile and uric acid is lessened, and later it is claimed that there is retrenchment of the assimilative functions, reacting on the intestinal organs, the colon contracting, while the "small intestine retains all but the most irritating ingesta."

Beyond question, by temporarily depriving the body of the supply of food it has been continually ingesting in excess of actual needs, we give the organs of elimination a chance to clean the polluted sewers, and to unload the superfluous impurities by the various eliminative organs, which exerts a beneficial effect to the whole organism.

Long-continued Undernutrition.—Man, after all, is more or less a creature of habit, and really the whole question of the amount of food daily ingested is essentially one of habit. As Chittenden(12) has aptly said:

> The so-called cravings of appetite are purely the result of habit. A habit, once acquired and persistently followed, soon has us in its grasp, and then any deviation therefrom disturbs our physiological equilibrium. The system makes complaint and we experience a craving, it may be, for that to which the body has become accustomed, even though this something be, in the long run, distinctly injurious to the welfare of the body. There has thus come about a sentiment that the cravings of the appetite for food are to be fully satisfied, and this is merely obedience to Nature's laws. The idea, however, is fundamentally wrong. Anyone with a little persistence can change his or her habits of life, change the whole order of cravings, thus demonstrating that the latter are purely artificial, and that they have no necessary connection with the welfare or needs of the body. In other words, dietetic requirements are to be founded, not upon so-called instinct and craving, but upon reason and intelligence.

After all, undernutrition can only be followed by disastrous results if long continued. Many are the human derelicts stranded on the rocks of semistarvation, "especially of protein starvation, the result of having been compelled to subsist, as many poor but respectable people have been, for a prolonged period upon 'bread and tea' because of the deficiency of protein in these foods. Deficiency of protein leads to wasting and degeneration of all muscular and nervous tissues; and, even when it is barely

sufficient, the individual does not always ultimately recover, but is prone to remain neurotic and subject to many ailments."

Fasting Experiments.—Fasting, of late years, has been attempted either by love of notoriety or desire for pecuniary gain by persons exhibiting themselves for gratification of public curiosity. They are generally frauds and are fed by some one in collusion with them. In a number of cases, the subjects have been carefully studied by medical experts, and there is no question that in some instances, at least, the fasts have been conducted with honesty. Thompson(3) reports two authenticated fasts where Tanner and Succi were the subjects. A period of starvation was prolonged for 40 days and over. In both instances fluids were allowed, and in one of the men intense epigastric pain and food craving was ameliorated by medication.

"Succi, an Italian subject, in 1890, undertook an absolute fast of 40 days, during which time he lost 42½ pounds and drank an average of 25½ ounces of water daily. The water he consumed was in the form of plain water, mineral water and ice. He lost flesh very rapidly during the fast, but on the last day he had strength sufficient to walk around the room. When he resumed eating he first took cocoa and subsequently bouillon and other light liquid diet, gradually returning to solid food. His mental faculties were unimpaired throughout. He occasionally took small doses of a few drops of an elixir supposed to contain opium."

Luigi Cornaro, a Venetian gentleman, published a treatise on a "Temperate Life," advocating a very abstemious diet. He says:

> I do not know whether some desperate degrees of abstinence would not have the same effect upon other men, as they had upon Atticus who, weary of his life as well as his physicians, by long and cruel pains of a dropsical gout, and despairing of any cure, resolved by degrees to starve himself to death, and went so far, that the physicians found he had ended his disease instead of his life!

His case is often referred to as an illustration of the smallest quantity of food which will support life. In his early days he was a reckless, intemperate youth, and spent his time "in riotous living." Later he reformed and by careful dieting prolonged his life to 103 years. During the last 48 years of his existence, he subsisted largely on an allowance of twelve ounces of vegetable food and 14 ounces of wine. Occasionally, he partook of eggs, but rarely took any other form of animal food. While there may be much wisdom in his doctrines as published, unfortunately no one who has attempted to put his teachings into practice has been similarly rewarded with a long life. The majority of mankind would,

for the pleasures of the palate, prefer to live fewer years in lieu of the pleasure of being less abstemious.

Periods of voluntary fasting of varying duration are practiced by devotees of religious sects. This practice was formerly indulged in to a greater extent by ascetics than at the present time. Such practices, unless they be definitely limited and supervised, may be carried to an excessive or even injurious degree. When a man by fasting reduces himself to the extent that his intellectual faculties are obtunded, he may be sure that he is doing himself injury. It would be far better for such individuals, for purposes of mental discipline or religious motives, to eliminate temporarily from the diet accustomed luxuries, or give up such articles in the daily ration as butter, sugar, salt, wine, tobacco, etc. This, in fact, is a custom practiced by many persons during the season of Lent. Contrary to the opinion once held by the laity, fasting cannot be regarded as favoring either clearness of intellect, muscular strength or endurance. Gerland emphasizes the folly of such practices, "the ethnologist can trace the physical and mental decay of whole nations to a long course of insufficient food."

Dr. William Stark, a young English physician, lived for forty-four days on bread and water, for a month on bread, water and sugar, and for three weeks on bread, water and olive oil. At the end of his experiments he was in a very enfeebled state of health; he developed symptoms resembling scurvy, and ultimately died, apparently a victim of his own scientific enthusiasm(13).

Effect of Fasting on Metabolism.—A knowledge of the metabolic changes occurring during a fast is of great importance both physiologically and pathologically. Many important physiologic discoveries were made possible by experiments on fasting animals and men, while pathology has benefited by examinations of diseased persons who were starving or nearly starving.

The effects of fasting on metabolism have been studied at length by Benedict(14). He carried out an experiment on a man during a seven days' fast. He found the loss was estimated to be: protein 69.5, fat 139.6, glycogen 23 grams per day, yielding 1,597 calories. The loss of protein equaled 347 grams of flesh; the actual loss of energy measured by the calorimeter was 1,696 calories per day or 100 grams more. The heat of combustion can be calculated from the known heat value of the substances, 1 gram of body protein yielding 5.65 calories, and 1 gram of fat 9.54 calories, and the total when fully oxidized would aggregate about 1,734, so that during a fast the organism lives on its own flesh and fat.

The changes in the metabolism produced by sickness cannot be accurately determined without a knowledge of the changes due to simple inanition. The knowledge of the pathology of the metabolism of fasting is sensibly incomplete, though many additions have been made to it during the past few years.

During the first few days of a fast, a man lives upon body glycogen, then upon his own protein and fat. In consequence, his respiratory quotient falls, which indicates the combustion of carbohydrates—to approach the values indicating the consumption of protein or fat. The more abundantly a man is fed preceding his fast, the greater will be his reserve supply of glycogen when the fast begins, and as a result, the more slowly will his respiratory quotient diminish. This explains the difference, during the first few days of fasting, between the well-fed men observed by Breithaupt and the underfed observed by Cetti (15).

FASTING METABOLIC EXPERIMENTS

Days of Fast	Cetti			Breithaupt		
	Per Kg. per Minute			Per Kg. per Minute		
	O_2	CO_2	Respiratory Quotient	O_2	CO_2	Respiratory Quotient
1	4.86	3.51	0.72	3.96	3.48	0.78
2	4.59	3.13	0.68	4.32	3.19	0.74
3	4.48	3.07	0.68	4.26	3.12	0.73
4	4.78	3.10	0.65	4.38	3.19	0.73
5	4.68	3.10	0.66	4.37	2.75	0.63
6	4.67	3.13	0.67	4.35	2.26	0.86
7	5.06	3.39	0.67	3.76	2.60	0.69
8	4.89	3.33	0.68	4.07	2.94	0.72
9	4.62	3.10	0.67			
10	4.67	3.16	0.68			

Von Noorden, in commenting on the results tabulated in the above table, says:

> The fact that the respiratory quotient at times fell below the theoretical minimum is explained by the conclusion that during repose and abstinence from all voluntary movements, small quantities of glycogen arising from the decomposition of protein collect in the liver and muscles.

If this is so, muscular work, which decreases the decomposition of glycogen, must also increase the respiratory quotient.

It is of great practical importance to know whether the physiological

laws of prolonged fasting hold good in chronic malnutrition. An individual in a condition of undernutrition through insufficient feeding might, under favorable circumstances, indulge in extravagant metabolism, as he does in acute fasting. "Again, he might establish a sort of automatic and purposive regulation, diminishing the amount of his metabolism when placed on a continuously inadequate diet." This brings up the interesting question, "What amount of food is necessary to maintain patients who are markedly emaciated from prolonged fasting."

A case much quoted, recorded by Klemperer, emphasized the food required to maintain nitrogen equilibrium. "A tailoress, aged 22, had been improperly nourished, and her weight fell from 50 to 36 kilograms; for eleven days she remained in nitrogen equilibrium at 18 calories per kilogram." Klemperer concluded that, as she was in nitrogen equilibrium, his patient was also in heat equilibrium, so that her diet of maintenance would be at the rate of 18 calories per kilogram of body weight per day. Von Noorden points out the error of Klemperer's conclusion, with the suggestion that after protracted malnutrition, the organism can retain nitrogen to build up the cells demanding protoplasm, even when on a scanty nitrogen diet. Von Noorden says:

> When a poorly nourished individual after a protracted fast is allowed food, in an increased amount, sufficient to overcome the decrease in bodily heat, an effort is at once made to retain nitrogen and repair the loss of cellular material that has occurred. This retention of nitrogen goes on until the body has readjusted itself to the new conditions of nutrition. Then the loss of nitrogen begins anew, unless the calories required have been adequately supplied.

Von Noorden conducted many experiments to determine the requisite calories per kilogram per day, in order to maintain a permanent increase of weight, and found it did not occur until an intake of 30 to 32 calories was reached.

PERVERSIONS OF APPETITE

Parorexia.—Parorexia(16), or perversion of appetite, is manifested for special or peculiar kinds of fat. There are three types:

(*a*) Malacia, a desire for highly spiced foods, such as mustard, vinegar or green fruits, etc.

(*b*) Pica, an inexorable desire for substances which are not foods, such as earth, chalk, pencils, ashes, sand and insects, etc.

(*c*) Allotriophagia, an insatiable craving for disgusting and harmful substances, such as fecal matter, pins, etc.

Malacia is often observed in cases of disturbances of the stomach and neurasthenia, while the other types are found chiefly in idiots, lunatics or in severe hysteria.

Anorexia.—Anorexia is loss of appetite, practically amounting to disgust for food, and is a precursor of acute gastric or intestinal disorders. In prolonged fevers such as typhoid, and some types of malarial infection, it may become necessary to force the appetite. In some instances the patient will feel a loathing for foods, or there may be absolute nausea; at other times the patient may have a feeling that he simply cannot eat, but the thought or sight of food is not repulsive; again, the patient may have a slight desire for food, but from prejudice or otherwise, which may amount to a delusion, he feels that food would add to his distress.

There is great diversity of differences in the appetite of individuals and even in the same individual at different times. Repression of desires for food, excessive self-control and habitual abstemiousness, practically amounting to obsessions, obtund the enjoyment of food. Whether due to actual lack of food, poverty, preoccupation or what not, the tonicity of the organs of digestion as well as of the musculature is seriously interfered with by prolonged insufficiency of diet. Nervous anorexia is a diminution of appetite, with absence of the hunger sense, so that even antipathy to food may be present. This condition is present in most of the organic as well as in the functional disorders of the stomach, but the nervous type appears as a primary affection, and has been attributed to a depressed condition of the hunger center, or to hyperesthesia of the mucous membrane of the stomach.

Bulimia.—Bulimia, or hyperorexia, is the habit of moderate overeating by comparatively healthy individuals, and may be due in some instances to an erroneous conception of the actual amount of food necessary to maintain life. There seems to exist a popular impression that the standard of strength may be heightened or a reserve of vital force established by superalimentation.

Certain diseased conditions, as intestinal parasites (not that the worms consume any notable quantity of nutrients), states in which the food passes rapidly from the stomach, certain forms of epilepsy and general paresis, sudden transition from the lap of luxury to poverty, may cause bulimia of a severe type. At times bulimia may be purely a matter of indulgence of the grosser appetites. For example, Benedict(14) reports the case of a young woman, otherwise dainty and refined, who would deliberately excuse herself from the table, induce vomiting by running her finger down her throat, empty her stomach and return to the table to eat

another hearty meal. This method was frequently practiced by the Romans during their Lucullan banquets.

Polyphagia.—Polyphagia is the demand for large quantities of food before satiation occurs. The cases do not feel satisfied until the food is digested. It often occurs as a primary condition in neurotics, or secondary to disease of the gall bladder, spleen, diabetes or brain tumor. Kemp(16) records a case that consumed 100 pounds of meat in 24 hours.

Akoria.—Akoria is the absence of satiety. Individuals with akoria never feel that they are fully fed. In fact, they never know when to stop eating. Sometimes this condition is combined with polyphagia, and is most often met with in neurasthenics and hysterics.

Polydipsia.—Polydipsia, or excessive thirst, is symptomatic of diabetes mellitus and insipidus. It may be due to diarrhea, which it tends to maintain; to the ingestion of large quantities of salt and sugar, requiring dilution; to strenuous exercise, causing loss of water by excessive perspiration; and if occurring very suddenly, it may indicate hemorrhage. Under some circumstances, it is due to habit, especially that of excessive tippling, more especially if the beverages contain xanthin. The drinking of water and milk in excessive quantities is a bad habit from a health point of view and is often indulged in through misconceptions of the hygienic value of liquid nutriment. This misconceived habit sometimes produces gastric dilatation in athletes, who endeavor to encourage strength and vitality by gulping large quantities of milk. Unfortunately health cranks, and many physicians as well, freely urge the drinking of excessive quantities of water, overestimating its value as an eliminant. The excretion of large amounts of water, free or nearly so from mineral salts, interferes more or less with osmotic processes generally by withdrawing the salts from the blood and tissues, and putting extra work on the circulatory glandular and renal organs. If pure water is used, its irritant effect on the gastric mucosa must be considered. There are persons, however, especially the indolent and overworked, middle-aged and elderly women, who drink quantities of concentrated tea. This habit tends to develop a distaste for water. In such conditions, as will be seen, all the processes of the elimination and secretion are interfered with.

Rumination.—Rumination applies more particularly to animals that chew the cud, whose stomachs are divided into four compartments. The first or largest division of typical ruminants is designated as the paunch; the second, the reticulum; the third, the osmasum psalterium or manyplies, and the fourth the abomasum or rennet bag. The ruminants swallow

herbaceous food unchewed and it is passed into the paunch, whence later it is regurgitated in masses and thoroughly masticated and mixed with saliva while the animal rests, after which it is again swallowed.

Merycism.—Merycism is a peculiar condition, rare, but sometimes found in neurotics who have the power of regurgitating food from the stomach. In some instances it has been claimed that they are able to bring up any particular article of food swallowed. Benedict, in discussing this point, describes the habit as a pleasant one, which seems as a rule to do no harm, except as any neurotic indulgence, but doubts the possibility of selective regurgitation. The regurgitated morsel is said to often retain its original flavor, without sourness or bitterness, which would indicate a deficiency of acid secretion and peptonization or possibly some abnormality, on account of which the foodstuff is retained in the esophagus.

The regurgitation of small quantities of the gastric contents occurs either as *water-brash* or otherwise with or without cardialgia—*heartburn.* This condition indicates a relative disproportion of function between endogastric tension and the normal tonicity of the cardiac sphincter. The most frequent cause of this condition is the use of too much liquid with a meal, or too hasty swallowing, so that too much air is introduced, or to fermentation of the stomach contents. Tonicity of the cardiac sphincter is largely a characteristic of the individual. For this reason, some persons cannot follow a vocation which requires stooping over soon after mealtime without regurgitating food from the stomach.

Vomiting.—Vomiting occurs as a symptom of so many diseases and functional derangements that we will not attempt to consider the whole subject collectively, but will refer the readers to various text-books on the practice of medicine. Vomiting, so far as it is related to dietetics, may be caused by (*a*) excess of food, (*b*) food and drinks improperly combined, such as crabs and milk, beer and champagne, etc., (*c*) fermenting or poisonous food, (*d*) irritating and indigestible food, including that which is improperly cooked, (*e*) food that is eaten in too great haste and without proper mastication.

Vomiting is mainly a conservative process of evacuating excessive and irritating gastric contents. Individuals that do not vomit readily are more disposed than others to serious alimentary disturbances. Vomiting is always an indication of gastric disturbance or of biliary diseases. Intestinal obstruction, peritonitis, pelvic disease, etc., need not be considered here. Food which is wholesome and nourishing may cause nausea through association or environment. Thompson(3) records an example of this in the following story: A party of early California settlers while cross-

ing the continent were lost during a severe winter in the Sierras. When nearly dead of starvation some friendly Indians took compassion and fed them upon a delicious finely ground meal, which for some days was their staple article of diet, and on which they rapidly gained strength. Being at first unable to understand the Indians, the emigrants could not learn of what the meal was composed. When at length they found out that it was made from pounded dried grasshoppers they became so nauseated that they could not touch the food again.

Such vomiting may properly be termed a pure psychosis due to disgust. From a dietetic standpoint, this form is important, since the nutrition of many delicate patients depends largely upon whether food is prepared in a sanitary and hygienic manner and daintily served amid pleasant surroundings. (Volume II, Chapter IV, Hygiene of Eating.)

Hiccough.—Hiccough is an abrupt and involuntary spasmodic contraction of the diaphragm with coincident contraction of the epiglottis. The ordinary cause for this phenomenon is engendered in the stomach by the too rapid introduction of alimentary substances, by alcoholic drinks, carbonic acid, as well as by certain foods. It must be borne in mind, however, that it can also be caused by a deranged state of the nervous centers. If of brief duration, it is usually a gastric or esophageal reflex, more often the latter. Swallowing too rapidly, swallowing food that is too dry, or in boluses too large, will cause spasmodic esophageal peristalsis. Prolonged singultus is a psychosis due to various reflex stimuli, as from biliary calculi, pelvic disease, etc.

Aërophagia.—Aërophagia is to be distinguished from the eructation of gas due to the literal swallowing of air with food and drink. It must also be distinguished from gas produced by effervescence or fermentation, or from the action of gastric juices upon intestinal carbonates with the pylorus relaxed. Genuine aërophagia is an exaggerated condition of hiccough with the drawing of large quantities of air into the esophagus. It is more often a neurotic manifestation of hysteria, and while it may be associated with gas in the stomach it more often is excited by the causes of hiccough.

During an acute aërophagic attack, patients may suffer from dyspnea, tachycardia and cyanosis. These distressing symptoms, according to Aaron(17), are instantly relieved by introducing the stomach tube, which allows the air to escape. The distention of the stomach with air pushes the apex of the heart upward and to the left. This pressure on the ventricles rotates the heart on its axis and distorts the great vessels at its base. The distended stomach or esophagus may disturb the heart in a

reflex manner because the common innervation of these organs is through the vagi. Stimulation of the vagi causes a slowing of the heart. These factors often produce cardiac arrhythmias, which become apparent to the patients by periods of different pulse-rate and irregularities, causing them considerable worry and anxiety.

It is of the utmost importance that an accurate diagnosis be made, because the affection is easily remedied. The roentgen fluoroscope will always show the rise and fall of the thyroid cartilage. This is helpful when one is not sure of his diagnosis.

The examination of the stomach contents in all aërophagics shows the presence of bile. A positive reaction for bile, with eructations, is a pathognomonic sign. The eructation of the air acts as a siphon and frequently draws the bile from the duodenum backward into the stomach. The finding of bile in the gastric contents is decisive.

In the treatment of aërophagy, Aaron is in the habit of impressing his patient with the way he is distending his stomach with air. This can easily be done by telling him to belch and, while this is going on, asking him to keep his mouth open. While the mouth is open he cannot swallow air and the eructations quickly cease. At this stage it is wise to explain to the patient that he has been swallowing air instead of emptying the stomach of gas. In order to keep the mouth open a cork may be placed between the teeth and held there. In this way the air is prevented from entering the esophagus. Then again, in order to keep the thyroid cartilage from rising, one may tie a ribbon moderately tight around the neck. This not only is a direct restraint but also serves as a reminder to the patient. After all, aërophagia is more amenable to moral suasion than to dietetic treatment.

Seasickness.—Seasickness to some extent is produced or initiated by dietetic errors prior to or after sailing. It seems to be a disturbance of equilibrium partly visual but mainly due to actual motion of the vessel, and includes in its symptomatology and pathogeny a condition of shock and gastric irritability, sometimes one and sometimes the other being the predominant cause. A voyager from the tonic of the bracing sea air may inadvertently overeat and thereby overtax his digestive organs and cause vomiting. Some voyagers at sea can leave the table, vomit the first two or three courses of a dinner, return and finish the meal with astonishing equanimity. With such individuals nausea is not a persistent or annoying symptom. Others are always nauseated, but fail to evacuate the stomach contents, and consequently grow weak from lack of food. Still others, after severe experience with emesis, strongly crave and can actually

retain and digest, in defiance of all dietetic laws, substances which they could scarcely eat at home. Old cheese, dill pickles, canned oysters and similar incongruities of diet are indulged in without a qualm.

There is a class of individuals of both sexes, though the greater number are women, who become so ill at sea that they reach a serious condition of prostration, with whom the mere idea of food or even the suggestion from reading an elaborate menu, will produce nausea. Certain cases are almost entirely free from vomiting, even from nausea in the ordinary secondary sense, and from any definitely localized pain, but consist in a state of general medical shock with intense discomfort.

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CHAPTER VI

OVERFEEDING AND UNDERFEEDING

In these days of overflowing American plenty, superalimentation, with its physiological penalties and economic waste, is possibly more prevalent than underfeeding, because of the sybaritic indulgence in the pleasures of the table in the absence of the physical stress of more primitive social conditions. And when appetite becomes pathologically exaggerated, the physician of today knows no remedy; when it fails in disease, he dispenses the "bitter herb" of tradition—and hopes for the best.

Superalimentation: Overfeeding, Acute Overfeeding, Chronic Overfeeding; Overeating—Chronic Overeating, Gourmet, Gourmand, Glutton; Effects of Overeating—Biliousness, Intestinal Toxemia, Effects on Mental Powers; Habitual Overeating—Alimentary Toxemia, Effect on Internal Secretions, Effects on Children, Aged, Early Life, Idiosyncrasy; Metabolism of Overfeeding—Excess of Proteins and Carbohydrates, Convalescents.

Underfeeding: Chronic or Habitual Underfeeding; Maleficent Sequences of Underfeeding—Mental and Physical Deterioration, Diminished Resistance to Cold and Exposure, Disease, Effect on Digestive Organs, Underfeeding a Cause of Drinking and Crime; Protein Metabolism; Pathology of Metabolism of Starvation—Consumption of Energy in Chronic Malnutrition, Protein Metabolism in Acute Starvation, Secretion of Bile. the Blood, the Urine; Conclusions.

SUPERALIMENTATION

Of the terms, overfeeding and overeating, the latter is the more apt to apply to an adult, as children are *fed,* while men and women, who have come into the full possession of their mental faculties and reasoning powers, may, of their own volition, eat too much. Overfeeding from the medical standpoint will be discussed later.

It is no easy matter to determine exactly what the word *overeating* implies. So many circumstances must be taken into consideration. But speaking broadly, it may be stated with little fear of contradiction that

the tendency of civilized people, especially of those who are prosperous, is to eat more than is good for their health, mentally or physically. Of course, primitive people, when they have the opportunity, almost invariably surfeit themselves, but their powers of digestion and assimilation are usually equal to the occasion. Again, poor people, when temporary prosperity admits of the indulgence of their appetite for food, are inclined to gorge themselves.

Overfeeding.—However, *acute overfeeding*, as it may be termed, does not call for an extended consideration. It is true that, in the old days, it has been recorded more than once that individuals succumbed to the consumption of very large quantities of food. For instance, King Henry II of England is said to have died as the result of eating gluttonously of lampreys, fish of which he was immoderately fond. But he, together with other historical examples of the ill effects of overeating, were chronic indulgers in the pleasures of the table, and merely hastened their end by eating an unduly large meal of indigestible food material. A death of this description is generally due to interference by a distended stomach with the action of an enfeebled heart.

It may be reiterated that people rarely die of surfeit in these days, but that *chronic overfeeding*, or the habitual ingestion of an excessive amount of nutriment, is common. In addition, the question of overeating must now be regarded in an altogether different sense from that in which it was formerly regarded. No longer does superalimentation mean the same as the word in the old sense signified. Our physiological standards of overeating have greatly changed. Former accepted standards have been cast aside, and an entirely revised and very much lowered physiological standard has been set up, by which it would appear that the population of the whole civilized world is addicted to ingesting more food than is in keeping with the strict tenets of good health, and is consequently laying up for itself divers kinds of pains and penalties affecting body and mind.

While it is evident that the food faddist is actively preaching his gospel of extreme moderation in eating, throughout the length and breadth of every cultured land, and that, like all faddists, he is something of a fanatic, yet the truth remains that there is method in his madness, and that his deductions are based on a sound and scientific substratum of fact.

There is no smoke without fire, and whenever an abuse exists on a wide scale prophets will arise to point the way we should go. Food faddists are prevalent and multiply for the very good reason that abuse of food, so far as quantity and properties are concerned, is widespread. There is

no doubt that among the prosperous members of a modern community, eating to excess is a frequent vice or fault, particularly among those who have been endowed with a large share of this world's goods. It will be tiresome to further enlarge on this phase of the subject, and without any more elaboration we will conclude that superalimentation is widely prevalent. More notice is now taken of the matter, because the population of the world has enormously increased, and therefore the food question is all important; and also because a new physiological standard has been erected by scientific men who have delved into the matter, the outcome of whose findings is, on the whole, recognized as correct by the scientific medical profession.

But before going into the question from the more scientific standpoint, it may be as well to discuss superalimentation from the general, rather than scientific, aspect.

Overeating.—Overeating is very liable to become a habit, and with indulgence the habit becomes a vice. A moderate excess of food is probably not only harmless but even good for the health. For those who work hard in the open air, of course, a considerable amount of nourishing food is required; for sedentary workers, a great deal less aliment is indicated, but, as a rule, it is wise to allow a certain amount of leeway, with regard to the quantity of food ingested. It is an extremely difficult matter to lay down hard and fast rules about the amount of food material an individual should ingest. The personal equation must always be considered. Regarding the matter from the wide outlook of the mass of the population, it can be said, with as much dogmatism as it is right to place on any statement, that the average fairly healthy person living in the ordinary civilized community, will take no harm and probably may benefit from ingesting more food than the amount that is laid down by scientific experts, as furnishing sufficient nourishment energy for the smooth and efficient working of the human machine. It may occur, and will occur, that an unexpected and severe strain may be put on this machine, and in order to cope successfully with or resist this extra pressure without injury to its delicate mechanism, some reserve force is needed. A mental strain or physical strain may call for the existence of such a reserve, although naturally the chief reason will be that one is compelled to go without food for a protracted period. In this event, a reserve of food within the body will greatly assist in maintaining the vital forces and is indeed necessary to offset, to some extent, the drain caused by lack of food. It is obvious that such a reserve can only be insured by eating more food than the body actually requires to meet its necessities. It is by following this principle,

by instinct, probably, that primitive men and animals embraced the opportunity whenever it presented itself, of gorging themselves with food.

Following a similar line of reasoning, the consumption of an especially large meal on Sunday by workmen can be explained and condoned from the physiological standpoint. By eating very heartily on at least one day of the week the workman is putting by a reserve supply from which to partially draw the energy needed throughout the week.

A surplus of this kind can hardly be termed an excess, and it is with acute and chronic overeating that we are concerned.

It has already been stated that although persons have been known to die of a surfeit, the occurrence in modern times, at any rate, is extremely infrequent. The harmful effects of too great a consumption of food at one time are local rather than general. The digestive organs, chiefly, suffer. Vomiting may result and may relieve the overtaxed stomach, or if the food reaches the intestine it will probably decompose before it is all absorbed, and diarrhea in this instance will act as a safety valve.

If the process of assimilation does not keep pace with that of absorption, some of the surplus products of digestion will pass out of the system by way of the blood stream, that is, with the assistance of the kidneys. This mode of rescue is one that is not often employed, although, that it is on occasions, is demonstrated by the fact that a great excess of protein in the food may give rise to transient albuminuria. On the other hand, if the consumption of carbohydrates has been extravagantly large, sugar may for a time appear in the urine.

Chronic overeating is a different matter and its ill effects are brought about in a more insidious manner. As a result of excessive eating or gluttony, the stomach and bowels become enlarged, the liver engorged and a predisposition is established to degenerative changes of the heart and arteries. The general results of habitual overeating seem largely to depend upon the food material which forms the greater part of the nutriment ingested. For example, if carbohydrate or fat is the food of choice, then the surplus is stored up in the form of fat, and the outcome is obesity. Protein material can hardly be stored in this fashion, for as Hutchison has pointed out, so great is the tendency of "nitrogenous equilibrium" to assert itself that the body can only "lay on" protein for very short periods, unless the process of growth is still going on. The same authority is of the opinion that what usually appears to happen is that the surplus protein is split up into two portions, one of which contains most of the carbon and is probably converted into fat and stored in that form, while the nitrogen-containing part is broken down, but not, perhaps, very rapidly and com-

pletely, so that the products which represent the intermediate steps in its destruction circulate for some time in the blood before being excreted in the form of urea. Some of these products may be factors in the production of such conditions as granular degeneration of the kidneys, high arterial tension, gout and rheumatism. Many observers think that they are partly responsible for diseases of this character, but the more conservative and the majority of those who have made a special study of the subject prefer to reserve their decision and to await more definite proof before laying down the law on these points. In this connection, it is well to bear in mind that an excess of protein sparers in the blood may produce very similar results to an excess of protein itself by shielding the latter from complete and rapid oxidation.

It may be taken as proved that gourmandizing or gluttony, whether done only on occasions or pursued as a habit, is by no means beneficial to the physical or mental attributes of the human organism. Chronic gourmandizing is more injurious to health by far than the occasional stuffing one's self with food, as it is doubtful whether an occasional excess, unless carried to the extreme, is harmful.

On the mental faculties eating to excess has a remarkably pernicious effect, but before dealing with some of the ills of the body and mind, induced, fostered and aggravated by overloading the stomach and intestine and overtaxing the digestive powers by greedy eating, gluttony from the historical standpoint will be briefly discussed. There have been some notorious gluttons, and there have been and are races of people who appear to have an abnormal capacity for eating, and there are civilized individuals at the present time who exhibit wonderful powers of consuming portentous quantities of food.

There is a French proverb: *"Ceux qui s'indigerent ou qui s'erviverent ne savent ni boire ni manger"* (Those who eat to surfeit or tipple to saturation know not how to eat or drink). Such as these are gluttons in contradistinction to epicures or gourmets. The epicure is an artist in the choice of food and generally indulges somewhat sparingly in carefully selected food and rare viands, while the glutton is a gross consumer of coarse food and strong, crude drinks. The *gourmet* is a dainty eater, while the glutton is a boorish consumer of immense quantities of heavy food.[1] The word gluttony, which expresses precisely the act of eating to excess, is derived from the Latin *glutire*, to glut, to swallow greedily, to gorge, to devour. As the French are the acknowledged arbiters of artistic, refined eating, they possess in their language several terms to denominate

[1] Anonymous author in "Dining and Its Amenities," published by Rebman Co.

and distinguish between the various kinds of eaters. Some French writers make nice distinctions between the appellations *gourmand* and *glutton.* The gourmand, they say, loves good cheer, but eats with judgment. The glutton devours noisily and greedily all food upon which he can lay his hands. The older editions of the Academy's dictionary make no such distinctions, and look upon the gourmand as synonymous with the glutton, and many French writers accept this definition. In the most correct French of the present time, the word gourmet is used in place of gourmand, meaning a careful eater, but a connoisseur of the art of dining. In the English language gluttony is practically identical with gourmandizing, greediness, edacity, gulosity and voracity. Gluttony, however, is the word most frequently in use to define the possession of an insatiable appetite for food. The boa constrictor may be regarded as the supreme type of the colossal glutton. Though perhaps not wholly in place in a work on diet, it may be remarked that gluttony is often employed metaphorically when reference is made to men who give themselves up to excessive mental effort. Thus a hard-working business or professional man is called a glutton for work; the elder Pliny was termed by a contemporary a literary glutton on account of his custom of mentally devouring every kind of accessible writing. The individual who indiscriminately devours writings of any kind, being able to assimilate only a small part of them, is as much of a literary glutton as the voracious devourer of any sort of food is a glutton in the ordinary sense of the word.

The glutton living in a civilized country differs from his primitive brethren and his somewhat more distant relatives, the carnivora and omnivora, in that their appetite is instinctive and natural, while his is abnormal and not infrequently morbid. There are men who are large eaters without being gluttons. The human glutton is in a class by himself and is marked by certain unpleasant but significant characteristics. He is essentially a gross eater to whom quantity is of more importance than quality and who persistently and with intent gorges himself to repletion. Of course, there are gluttons who should be named rather gourmands, for, after all, there is a shade of difference between the terms; gourmands, while immense and voracious eaters, are nevertheless careful in choice of food and drink. Of all the gluttons whose names appear in history, that of the greedy Heliogabalus comes to mind as the archetype of gluttony. Alexander the Great, who was glutton in everything, died at an early age from the effects of a protracted debauch, and the Emperor Septimus Severus succumbed to acute indigestion brought on by overeating and vinous excess.

The glutton is limned to the life by the inimitable art of Shakespeare in the person of Sir John Falstaff; in many of the immortal bard's plays vivid and lifelike verbal pictures of the glutton are presented. In the time of Shakespeare, be it remembered, gross eating and heavy drinking were customary, and in polite society the glutton was not looked at askance. To be a good trencher man was esteemed a virtue rather than a vice. To hark further back than the time of Shakespeare to that of another of the greatest poets of the world, Homer, we find that to eat gluttonously and to drink unstintedly was regarded as an almost necessary attribute of a good fighting man. As it was heroic to kill one's enemies, so it was the part of the militant hero to consume unlimited quantities of food and drink. As an historical, possibly legendary, example of capacity for food, it is related in the verses of the poet Berchoux, who told in charming rhymes of the pleasures of the table and of the doughty deeds of his gastronomic heroes, that during one morning Albinus consumed five hundred figs, one hundred peaches, ten melons, twenty pounds of muscat grapes, one hundred fig pickers and four hundred and eight oysters. Truly there were gastronomic giants in those days.

The Tartars have always been conspicuous as great meat eaters and heavy drinkers, and, if their powers in this direction have not been belied, Genghis Khan, Tamerlane and others of the earlier Tartar warriors well upheld the traditions of their race as carnivorous gluttons. Of European people the Norsemen and the Saxons ate and drank inordinately, while the Normans were more fastidious in their choice of food.

Louis XIV of France was a voracious eater. It is told by chroniclers of his time that he frequently ate at one sitting four plates of different soups, a whole pheasant, a partridge, a copious serving of salad, some roast mutton, two good sized slices of ham, a fair share of pastry, and for dessert preserved fruits, nuts, etc. A very favorite dish of his was hard boiled eggs.[1]

Charles V was as big a glutton as he was an epicure. At a dinner of

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[1] Of old the palate ran riot. The Romans were both epicures and gluttons. The oysters of Britain were conveyed by relays of runners to the Roman villas. One epicure cast a slave into his fishpond to improve the flavor of his lampreys. The most absurd dishes were contrived, up to a pie of nightingales' tongues. Their tastes were not ours. Fowls were boiled in aniseed water, and served with a sauce containing aniseed, mint, mustard seeds and asafetida. Nor were the middle ages far different. Charles IV, of Germany, was a notorious gourmand. Besides ordinary meats he had roasted horse, cats in jelly, lizard soup, fried frogs, etc., till his chef, when asked for a new dish, could only suggest a compote of watches—in allusion to that monarch's passion for such timekeepers.

the Knights of the Golden Fleece, Roger Ascham saw him make his way through sod beef, roast mutton and baked hare, after which he fed full well on a capon. Nor did he forget to drink with it all. "He had his head in the glass five times as long as any of them, and drank no less at once than a quart of Rhine wine." It is further narrated that he became a victim of gout.

In more modern times the Duc d'Escars died within twelve hours after eating too freely of the famous dish of *truffles à la purée d'ortolans,* devised by Louis XVIII.

Overeating generally is more prevalent in modern times and among civilized communities than in the days of yore, for the reason that there are more persons who can afford to indulge their propensities in this direction. *Per contra,* there are fewer people who eat and drink to an immoderate extent. While the ancient vice of gluttony has been handed down from generation to generation, there are few, if any, instances of unbridled voracity which can be compared with those told in the annals of great gastronomic feats. Still the race of gluttons is by no means extinct, and it will be pertinent to cite a case or two of gluttony carried to extreme limits, by modern emulators of the gourmandizing exploits of men of ancient times and of the middle ages. Savarin in his fourth "Meditation," section "Grands Appetits," states that a General Bisson drank eight bottles of wine with his copious breakfast, and that Prosper Sibuet, when eighteen years of age, on a wager, devoured a whole turkey after having eaten a bountiful dinner.

Sergeant M. A. Hunter, Quartermasters' Corps, U. S. A., related to the author that he witnessed an exhibition of abnormal capacity for ingesting food when he was stationed at Fort Apache just before the outbreak of the Spanish-American War. A detachment of raw recruits were sent to Fort Apache, and among these were several Poles and Russians, who were enormous meat eaters. The Sergeant says that the quantity of meat these men could consume quickly attracted the attention of the Mess Sergeant of the company, and a gourmandizing trial of strength was arranged between the champions of each race. After a lengthy encounter the Russian gained the victory, having swallowed 23½ pounds of roast rare beef.

Reference was made in a former part of this chapter to the eating powers displayed by certain races, and in the opening chapter of the first volume, dealing with the evolution of man's diet, some examples were given of these powers. Of races which inhabit the world at the present time, the Eskimo stands supreme as a devourer of meat. Cook stated that they eat but one meal a day and then gorge themselves with tough meat

so that they develop big jaws and enormously distended abdomens. Hayes, on an exploring expedition, had an opportunity to study the habits of these people, and says that it is not uncommon for an Eskimo to eat from 12 to 15 pounds of food, about one-third of which is fat and the rest muscle meat. Captain Hall, when on his Arctic expedition, declares that he saw a native Eskimo eat 20 pounds of raw meat and consume a quart of train oil within 24 hours.

Many primitive people of the present day both in tropical and cold climates eat immensely, but as said before, while eating too much has increased generally in civilized countries, cases of inordinate eating are more rare. Gluttony in civilized people is regarded not only as a sin against the laws of health, but as a repulsive means of gratifying the sensual appetites, fraught with the most grave consequences. It is frowned upon and stigmatized in polite society, and he who sins in this respect is looked upon with contempt.

Effects of Overeating.—The effects of overeating on the mind and body are more or less obvious. Overeating causes congestion of the liver, and a condition known as *"biliousness,"* in which the stomach and intestines are engorged. Constipation ensues, the tongue becomes heavily coated, the bodily secretions are altered in composition, and the urine especially becomes overloaded with salts. It is evident that we are not nourished by the food we eat, but by the amount we can properly use and assimilate. Probably, an excess beyond this amount is beneficial because it supplies a reserve upon which the body can depend for nourishment in time of need. However, it is absolutely patent that chronic overeating so clogs the machinery of the body that the organs of elimination and excretion are unable to work as they should, intestinal stasis follows, the surplus food material putrefies before it is absorbed in the intestine, the urinary tract becomes infected, the circulation becomes involved in the toxic invasion, and the whole system is poisoned.

This condition of *intestinal toxemia* brings in its train many mental and physical disabilities. The nervous and muscular systems become saturated with the end products of protein digestion, producing a state of lassitude, headache, fatigue, drowsiness and even mental stupor.

The effect of chronic overeating on the *mental powers* is very evident. Indeed, it may be laid down as an axiom that a person who habitually overeats is incapable of good or sustained mental work. The cross, irritable dyspeptic is too greatly occupied in worrying about his own ills to be able to employ his mental faculties in other and more useful channels. The brain worker or business man, who eats largely, especially in

the middle of the day, cannot use his mental powers properly. His mind loses its acuity and as for flights of imagination, if he is a literary man, these are impossible. Overeating is an insurmountable obstacle in the way of mental endeavor. The handicap placed upon the entire system as the result of overeating is too great to be overcome, and the mind refuses to respond to the stimulus of thought.

HABITUAL OVEREATING.—The effects of overeating on the body have been discussed already, and little remains to be added. It is known that habitual eating to excess will in course of time bring about *alimentary toxemia,* and it is more than surmised that this poisoning of the system by the waste food products is mainly and sometimes wholly responsible for many serious diseases, the maladies, for instance, so frequent in these days, known as chronic. However, until our knowledge on these points is more exact and definite, it would be unwise to speak very dogmatically, that is to say, it would be unwise to say with decision that such and such a disease, gout or rheumatism, for instance, is caused chiefly by overeating or errors of diet. This we do know and can state emphatically, that in the treatment of conditions of this nature, diet plays a very important, if not the most important, rôle.

There is another point in connection with habitual overeating which should not be overlooked, and that is its effect on the *internal secretions* concerned in the digestive process. We do not know enough of the mode of action of the secretory glands to state exactly and in detail what their province is, but we have learned that they have very much to do with the working of the human organism and that when they secrete deficiently ill health follows. Overeating no doubt unduly taxes the internal secretions, and this persistent strain results in their failure or partial failure to perform their normal functions. It is satisfactory to be able to state that knowledge about the internal secretions is increasing and that the time is approaching when the mystery that envelops them will be cleared away.

Children are often habitually overfed and the old frequently suffer from the effects of chronic overeating. There is little doubt that many of the ailments with which babies and young children are afflicted proceed from overfeeding. With most mothers the criterion of an infant's health is the amount of adipose deposit it carries. The fatter it is the prouder its parents are of it. The truth is that, as a rule, the fat baby is not the healthy baby.

The healthy baby can digest and assimilate easily and continuously an amount of food sufficient to produce normal growth. An excess of food

will not cause a corresponding excess in the rate of growth. A deficiency or excess of food continued for a length of time may check growth. The rickety child is frequently extremely fat, and it is certain that harm will result from giving the infant too much to eat.

With regard to overeating in the case of the *aged,* it goes without saying that the habit is to be deprecated. When middle age comes digestion often begins to lose its former vigor, and metabolism shows signs of flagging. With the gradual onset of old age digestive and metabolic activity further wanes. Consequently with the advance of age chronic overeating should be guarded against and simple foods should be taken sparingly. At the age of sixty an individual must reduce his intake, and at seventy his power has further diminished and the nutriment must correspond thereto, if he desires still another term of comfortable life.

Sir Henry Thompson(1) says: "I desire to point out that the system of 'supporting' aged persons, as it is termed, with increased quantities of food and stimulant, is an error of cardinal importance, and without doubt tends to shorten or embitter life." Overfeeding of young children and overeating in the case of aged persons are grave dietetic errors.

In *early life,* as Campbell has pointed out, most people can cope with a dietary which departs widely from the ideal; they are able to consume with comparative impunity not only far more food than is required, but also all sorts of foods which in later years cannot be tolerated. "Comparative impunity" is said with intention because chronic dietetic delinquencies, even in early life, cannot but be harmful in the long run, although an occasional lapse from a severely correct diet may in the case of the habitually abstemious, be actually beneficial, and this even after middle life.

The point which should be emphasized with regard to overeating is that chronic eating to excess is extremely injurious to health, while an occasional indulgence in this direction may do good rather than harm. Another point upon which stress should be laid, is that *idiosyncrasy* and custom count for a good deal in the capacity of the organism to cope with different kinds and quantities of food. The personal equation is always an important factor. Individuals vary greatly in their digestive and metabolic capacities. For example, some children are made ill by even a slight excess of food, while their grandparents, perhaps, can consume a large excess with comparative impunity. Adults in the prime of life differ widely in their digestive and metabolic capacities. One man can ingest without apparent injury an amount of food which another man leading exactly the same kind of life cannot tolerate. But often the pos-

session of great digestive and metabolic capacities is of doubtful value, as these are apt to be abused and the individual with what is termed a weak stomach frequently outlasts the person of strong, vigorous frame and sanguine temperament, largely owing to the fact that he has to be careful. The creaking gate frequently hangs the longest. Also the question of heredity plays a far greater part than many people imagine. Longevity is to a considerable extent a matter of inheritance.

There is another interesting point in connection with overeating that is deserving of passing mention. The *capacity* to cope with an excess of food differs in different races irrespective of climate or conditions of life. Custom exerts some influence. Thus the Jews seem to be conspicuous in this respect. They lead, as a rule, a sedentary life, and yet can habitually eat an excess of rich food without apparent injury to health, possibly for the reason that because far longer than any other race, on account of their prosperity, they have been able to obtain plenty of food, and have thus become racially adapted to it.

The question of overfeeding in contradistinction to overeating will now be considered.

Metabolism of Overfeeding.—Overfeeding, speaking from the standpoint of the medical man, signifies that the object to be attempted is the building up of fresh tissue in a person previously badly nourished or who has lost tissue as the result of disease. Von Noorden's definition of the term "overfeeding" is the administration of food in such a quantity as to provide more energy than the needs of the body require. According to the same authority, it is a matter of indifference whether the excess takes the form of albumin or of some oxidizable substance free from nitrogen.

EXCESS OF PROTEINS AND CARBOHYDRATES.—If fat is ingested in excessive amounts the greater part of the energy thus created passes into tissue substance. Carbohydrates consumed to an excessive extent do not afford nutriment to the tissues in the same way. Zuntz(2) has estimated that considerably less energy is generated for digestive purposes by carbohydrate consumption and that with coarse kinds of bread the energy loss is much less. In addition, it has been shown by Rubner and Zuntz that carbohydrate is not changed into fat with absolutely no loss of heat.

When nitrogenous substances compose the excess the results are different from those of fat on carbohydrate excess. Several investigators seem to have demonstrated that in these circumstances the processes of oxidation are augmented. Rubner(3) fed animals with a rich meat diet and obtained values appearing to show that a daily transformation of energy exceeding those in accord with the food necessary for main-

tenance by 30 or 40 per cent or more was necessary. However, when man is considered, no large amounts need to be taken into account. From the fact that he is omnivorous, it is known that only a comparatively small proportion of the food ingested can be replaced from protein. Rubner was able to distinguish two effects as the result of feeding on protein substances:

1. The primary effect of a meal rich in protein is an increase in the oxidation processes, which passes off in about eight to ten hours.

2. In certain circumstances, however, the continued use of a diet rich in protein leads to a long continued increase in the consumption of energy, which lasts as long as the excess of protein remains high. This increase in the waste of energy rises more quickly in accordance with the addition of protein.

From the standpoint of the most recent investigations, von Noorden (4) thinks that, in estimating the elements of the food by which an excess of calories is produced beyond the needs which form the basis of a diet to increase body weight, protein is the least suitable since along with a low caloric value the necessary oxidation processes must be considerably increased for its combustion. Consequently, very little of the surplus calories, which result from the excess of protein, are left at the disposal of the system. Howell (5) points out that if protein is eaten in excess of the real assimilation needs of the tissues, all the excess, as far as we can see, might just as well be substituted by carbohydrate or by carbohydrate and fat. The excess nitrogen thus eaten appears to be so much useless ballast which the body very promptly gets rid of.

Better results are obtained from *carbohydrates,* although in their case at least one-fourth of the store of energy contained in an excess of them is lost on the way from the stomach to its final storage as fat in the fat depots. Von Noorden is of the opinion that the conditions are most favorable in the case of fat, as very little expenditure of energy is required on the part of the digestive organs, and the fat is stored as such without any loss of energy. Rosenfeld (6) thinks that there is reason to believe that in animals like ourselves the carbohydrates are more easily and more quickly destroyed in the body than the fats, and that, therefore, the latter may be more readily deposited in the tissues, although an excess of carbohydrate beyond the actual needs of the body will also be preserved in the form of fat or glycogen. The modern point of view is that body fat is formed in the first instance from food fat and food carbohydrates. It is customary to teach and put into practice the theory that carbohydrates or fat and carbohydrates are best adapted for feeding purposes and,

despite the opinions of von Noorden, full use is seldom made of fat. However, that authority claims that, when certain pathological conditions of the stomach and intestines can be excluded, large and even enormous quantities of fat are well tolerated, with results that cannot be exceeded by an abundant exhibition of carbohydrates. This remark may be interpolated here that while emphasis has been laid upon the importance of overfeeding, that is, of providing what Meltzer has termed a "factor of safety," a certain margin beyond a bare sufficiency which will be a reserve against unusual demands, the question may be asked—what constitutes the assimilation need of the tissues? This must be known with more or less accuracy before the amount of the reserve required can be stated. If a man is accustomed to eat 100 grams of protein daily, and science demonstrates that he can maintain a nitrogen equilibrium on 30 grams, does a reasonable factor of safety require the use of the additional 70 grams, or would a less total per day, perhaps, meet every requirement? This is a point which should be elucidated by experiment and observation.

Von Noorden is of the opinion that the increase in the exchange of calories following the fattening of the body tissue depends on the following two factors.

1. The increase in the amount of protoplasm disintegrated, forms the most characteristic feature. When large quantities of fat are put on, the body accumulates material which adds to its weight but hardly contributes at all to the energy exchange. As a result, the balance of energy based upon the body weight falls, as a rule, in individuals who are being overfed. An addition of flesh, that is, an increase in protoplasm, augments the transformation of energy as shown by experiments made by Pfluger and Rubner. Zuntz(7) demonstrated that by systematic muscular exertion, continued for a considerable period, many of those experimented upon became thinner but gained a good deal of nitrogenous material. When the period of exertion was over the exchange of calories was higher, the casual factor being an increase in the protoplasm.

2. The increase in the actual size of the body, independent of the formation of protoplasm, necessitates an increase in the consumption of energy, which means that individuals of heavy weight require a greater expenditure of energy in order to move and raise their limbs and so on. It is not infrequently impossible to set up definite quantitative relationships between the addition of protoplasm and the increase in the transformation of energy.

In the present state of our knowledge, it will not be wise to go further than the following statements: (*a*) Every increase in the amount of pro-

toplasm increases the energy exchange. (*b*) An increase in weight, due to increased intake of fat, also increases the energy exchange. (*c*) With the ingestion of further quantities of protein, the energy exchange often rises independently of the increase in protoplasm, probably as the result of a peculiar irritative action of the food proteins on the active cells, the exact nature of which is unknown. Kraus(8) points out with regard to the conditions which obtain in convalescents that it has long been known that convalescents, like those who have been subjected for a long period of time to insufficient food, can be made to increase in weight more readily than well-nourished persons. It has been observed that an addition of protein can occur in wasted and enfeebled patients on a diet which in normally nourished individuals would be insufficient to permit a nitrogenous equilibrium to be attained. It was further observed that especially during convalescence from severe diseases considerable amounts of protein derived from the food were daily retained in the organism, and employed in rebuilding the damaged tissues.

CONVALESCENTS

Svenson(9) studied the conditions of convalescents during recovery from typhoid fever and pneumonia, the only ones as yet studied. In the first days after the fever had disappeared, the values for oxygen utilized and the carbonic acid given off were found very low. After a few days, however, the exchange of energy rose, and in the following first to second weeks reached values which exceeded the normal by about 30 to 50 per cent. If, despite the much more active processes of combustion, the convalescent increases in weight and puts on a good deal of flesh, this is due to the fact that the taking up of nutriment is still more decidedly raised than the energy exchange. According to Svenson, a food intake equal to 60 or 70 calories per day and per kilogram is not unusual in the convalescent. During the period of the marked putting on of protein and fat, the respiratory quotient rises considerably. This is exactly the reverse of what is met with in starvation when the respiratory quotient sinks abnormally. Von Noorden is inclined to doubt Svenson's figures and thinks that fresh experiments in this direction are called for.

An important point is that flesh formation occurs in every case in which the body has suffered from a loss consequent to starvation, underfeeding, or disease, and again returns to a more satisfactory state of nutrition. It should also be noted that the recuperative powers of the organism with regard to nitrogen retention come into evidence when the need for calories is not thoroughly satisfied. In this event, the tissues

have the preference when overfeeding is practiced. It is evident that the conditions for flesh accumulation are most favorable when an excess of food is combined with the efforts at regeneration on the part of the organism. Excess of food can be used to the best advantage only when the vital forces of the subject are recuperating. As said before, the sole exact experiments which have been made hitherto on this aspect of metabolism have been made on convalescents from typhoid fever and pneumonia.

The following figures, taken from von Norden, when compared with those obtained by feeding healthy individuals, show how markedly the activity of the accumulation of nitrogen is increased in convalescents:

TABLE EMPHASIZING THE INCREASED NITROGEN IN CONVALESCENTS, DUE TO OVERFEEDING

Days of Convalescence	Nitrogen in Food, Gms.	Calories in Food	Calories per Kg.	Daily accumulation of Nitrogen, Gms.	Weight, Kg.	Observers
15–27	18.69	3,188	55	......	56.5–69.4	
28–36	20.54	3,238	54	+6.54	59.4–61.4	Benedict and Suranyi (typhoid)
37–47	18.63	3,324	55	+7.69	61.4–64.3	
3–13	21.3	3,216 (average)	about 56	+7.56 +5.92	about 56 ——	*Ibid.* (typhoid)
14–17	21.92	4,327	73	+7.33	57.5–58.5	
18–25	17.04	4,215	71	+5.00	58.5–59.8	
26–34	28.29	4,589	74	+9.82	59.8–63.7	
35–42	27.17	3,598	56	+5.56	63.7–65.2	
43–62	27.24	2,912	44	+4.86	65.2–68.1	
3–13	18.20	2,775	50	+3.62	55.0–56.0	von Noorden, 1893, unpublished observation (typhoid)
14–23	18.20	2,775	48	+4.05	56.0–59.4	
24–33	18.20	2,775	46	+5.87	59.4–61.0	
4–10	19.10	2,180	42	+3.82	52.0–52.8	
11–18	19.10	2,380	45	+4.93	52.8–54.1	
19–23	20.20	2,600	48	+3.14	54.1–56.0	von Noorden, 1893, unpublished observation (after severe sepsis)

It may then be stated that the results of experiments carried out permit the conclusions that the nitrogen gain is absolutely, as well as relatively to the simultaneous putting on of fat, greatest in those convalescing from severe acute diseases. It is less, but still considerable, in patients

who were in a condition of inanition before the feeding was commenced, and whose body weight had fallen greatly below the average. Of course it follows that the smallest nitrogen gain is seen in individuals who were well nourished before the experiment began.

The following table, taken from von Noorden, refers to the manner in which the accumulation obtained through feeding is divided between nitrogenous material and fat:

TABLE SHOWING APPROXIMATE VALUES OF THE INTERCHANGE OF NITROGEN AND STORAGE, PROTEIN AND FAT, ABSOLUTE AND PERCENTAGE IN OVERFEEDING

Observers	Food Nitrogen Grams	Excess of Cal.	Of the Calories in Excess there were used in the Body: For Storage as Protein, Absolute Grams	For Storage as Protein, Per cent Grams	For Storage as Fat, Absolute Grams	For Storage as Fat, Per cent Grams	
Krug........	15.4	1,537	115	7.46	1,422	92.54	Healthy and well nourished
Kaufmann and	21.5	1,906	111	5.80	1,795	94.2	Healthy; moderate
Mohr......	18.4	2,775	170	6.10	2,605	93.9	state of nutrition
Kaufmann and	17.8	1,683	133	8.00	1,550	92.0	As before
Mohr......	17.0	2,830	204	7.20	2,626	92.8	
	30.8	367	20	5.40	347	94.6	
	30.9	355	86	24.20	269	75.8	
Lüthje.......	41.7	1,505	197	13.10	1,308	86.9	Healthy
	42.6	1,472	228	15.50	1,244	84.5	
	61.0	2,524	482	19.10	2,042	80.9	
Benedict and	18.7	790	227	28.70	563	71.3	Convalescent from
Suranyi....	20.5	733	268	36.60	465	63.4	typhoid
	18.6	738	263	35.60	475	64.4	
	24.3	830	206	24.80	624	75.2	
	21.9	1,723	255	14.80	1,468	85.2	
	17.6	1,594	174	10.90	1,420	89.1	
Benedict and	28.3	1,868	342	18.30	1,526	81.7	Convalescent from
Suranyi....	27.2	893	193	21.80	700	78.2	typhoid
	27.2	258	169	65.50	89	34.5	
	18.2	489	126	25.90	363	74.1	
von Noorden..	18.2	387	210	54.30	177	45.7	Convalescent from
	18.2	316	204	64.50	112	35.5	typhoid
	16.8	342	70	20.50	270	79.5	
	17.2	468	49	10.50	419	89.5	
von Noorden..	17.3	662	80	12.10	580	87.9	Stomach affection
	19.9	720	136	19.00	584	81.0	badly nourished
	18.0	558	143	25.60	415	74.4	
	18.1	707	118	16.70	589	83.3	
	19.1	1,795	57	3.20	1,738	9.68	
Hirschfield...	23.0	2,273	54	2.40	2,219	97.6	Badly nourished
	19.2	2,197	115	5.20	2,082	94.8	

The argument has been brought against these overfeeding cures that the increase of weight obtained soon disappears. Probably, this depends to some extent on the manner in which the treatment is conducted. The originator of this therapeutic method was Weir Mitchell, who always prescribed isolation, complete bodily rest, and aliment mainly of a carbohydrate character. However, it is not essential to follow Mitchell's trophotherapy to the letter, and in many instances, exercise in the open air, massage and so on are indicated. The main object is to administer a large amount of highly nutritious food in a relatively small volume and whether absolute rest is to be a part of the treatment, or exercise, must be left to the discretion of the physician. Personally we shall advocate exercise in conjunction with the dietetic régime. How long the gain in weight in consequence of overfeeding can be maintained must be taught by therapeutical experience rather than by exact experiments.

It has been pointed out that in the overfeeding treatment of wasted, ill-nourished persons, during the first weeks the body weight rises at a great rate, and this rise cannot be wholly explained by the accumulation of flesh and fat. The explanation probably is the large amount of water taken up by the blood and tissues. It is the accumulation of water in this manner that accounts for the rapid increase of weight during the first weeks. When diuresis increases the gain in weight slackens or stops, although flesh and fat are still being put on at much the same rate.

The numerous investigations which have been carried on within recent years with regard to the effects of overfeeding have, from the experimental standpoint, been somewhat confusing. While all the investigators appear to concur in the view that overfeeding is generally indicated in cases of malnutrition resulting from lack of food or from certain pathological conditions, the explanations as to what form of feeding should be followed or why, that is, from the strictly scientific point of view, are not altogether satisfactory. It must be borne in mind that up to the present time exact experiments on this aspect of metabolism have been made almost exclusively on convalescents from typhoid fever and pneumonia, and even these have been subjected to criticism. The explanations, other than those gained from exact experiments and from clinical experience, are after all no more than scientific surmises, although, of course, they are founded upon physiological and pathological facts and reënforced by profound knowledge as in the case of von Noorden.

Moreover, the point raised by Howell is well taken: that, when a reserve supply of food provided by overfeeding is spoken of, it will be necessary to find out as nearly as may be what constitutes the assimilation

need of the tissues. From the point of view, then, of experiments with regard to the metabolism of overfeeding, the question whether a genuine putting-on of flesh may be obtained from this method still remains unsolved.

From all the experiments made in this direction, the most important point which has been made clear is the great selective power which the body possesses in regard to foodstuffs given in excess. It must be emphasized that it is only by practical experience and not by experiments, except those which are generally conducted on animals, that we can learn if body weight can be increased when this is necessary, if it is to the benefit of the patient to use overfeeding and if so by what form of food this end may be best accomplished.

When we turn to the clinical evidence on this point, the results are more encouraging. Overfeeding in tuberculosis has been referred to in Volume III, Chapter V, and the treatment is likewise employed in certain forms of anemia and chlorosis, neurasthenia, hysteria, visceroptosis, malnutrition generally and especially in convalescence from various diseases, those of a febrile and infective nature in particular.

Weir Mitchell's mode of treatment and diet have been described in Volume II, Chapter XVI, and it only remains to say that, while the rest, treatment and judicious stuffing with food are suitable for and have benefited many, yet whether this kind of treatment should be followed or whether a combination of overfeeding and exercise should be used must be left to the discretion of the physician. We are distinctly inclined to advocate, as a rule, exercise and overfeeding. Much the same may be said with regard to the kind of food. Although carbohydrate food is recommended by perhaps the majority, fat and carbohydrate by many, and fat by von Noorden and others, there may be cases in which an excess of protein food in the shape of meat may be of the greatest benefit. No one dietetic procedure should be slavishly followed, but the physician should use his own judgment. On the whole, overfeeding by carbohydrates or fat and carbohydrates seems to have had the best results.

UNDERFEEDING

Underfeeding is by no means uncommon in civilized communities and in urban and in industrial centers in particular. The cause is generally poverty, as in all modern countries there is always a large proportion of the inhabitants who, while not actually starving, exist in a constant condition of semi-starvation. These people not only lack suffi-

cient food to satisfy their appetites, but they do not ingest enough nutriment to keep their bodies in good health. Also, and this is an important point, their diet is ill balanced and usually composed of innutritious food products. If the money they spend on food were expended judiciously, that is, scientifically, they would not be underfed. But in the first place it must be remembered that the poor are compelled to buy in the dearest market; they obtain the least value for the money they spend, and they are ignorant how to lay out to the best advantage the little they possess. This is especially the case with the city poor of the English speaking race. Probably no indigent people in the world buy food at such high rates and in such a foolish way as those who live in the big industrial cities of Great Britain. In the cities of America, too, a large proportion of the inhabitants exist on an ill-balanced diet. Perhaps here it is not so much a question of poverty as carelessness and laziness. The woman of the household prefers to buy her food ready cooked in delicatessen stores than to cook it at home. The consequence is that very large numbers drag out a bare existence continually, on the borderland of starvation. The Latin races, as a rule, live on cheap food which is, at the same time, nutritious. The Italian, for instance, subsists and does hard manual labor on food like macaroni; the majority of the inhabitants of Japan work hard and are muscular and vigorous on a diet consisting mainly of rice, and the list of these peoples who live, thrive and work hard on an inexpensive and nutritious diet, might be greatly amplified. However, the object aimed at is to demonstrate that underfeeding is widely prevalent in civilized lands rather than to explain the causes. It may be remarked, too, that children and women are the ones who suffer the most. The man has to have the greater and best part of the food supply, because he is the wage earner, and if he were not fed, however inadequate and ill chosen his food might be, he would not be able to work at all.

Accordingly, it may be taken for granted that, in civilized countries the world over, a goodly portion of the inhabitants are underfed; that this state of malnutrition is of various degrees of severity; that it is most prevalent in industrial countries, and that women and children suffer the most.

Underfeeding may also occur when the diet is normal, but the amount of work done is excessive.

Chronic or Habitual Underfeeding.—Chronic or habitual underfeeding is more injurious to the health than eating to excess. Attention has already been drawn to the fact that underfeeding is quite as much due to

the lack or deficiency in amount of one important constituent, as to lack of quantity. It is natural for a hungry person who has little to spend to prefer a bulky food possessing hardly any nutritive properties to a more concentrated and highly nutritious product. An individual also is largely governed by custom and taste. If she, for the woman is usually the buyer, likes tea and bread and butter and a bony herring, a form of diet to which she and her children have become addicted by long custom, these are articles in which she will invest her few cents. Therefore, it is the absolute truth that malnutrition is caused quite as often by an ill-balanced diet as by lack of quantity.

It is almost unbelievable how long a person can live without food, provided that water is obtainable. Professional fasters have frequently existed for 40 days and even longer with no sustenance except some water, and lunatics have been known to refuse food for four or five weeks at a stretch, all of which seems to show that starvation may be borne with a considerable degree of impunity. In this connection, although not exactly bearing on the subject under discussion, it is interesting to know that the sensations of starving persons are not particularly unpleasant. In the popular mind prolonged starvation is associated with great pain and distress, in spite of the denials of those who have undertaken starvation voluntarily. Such persons, almost without exception, have stated that, after the first three or four days of starvation, the sensation of hunger is no longer felt, or, at any rate, is not excessively painful or uncomfortable. It has been demonstrated by experiment, that it is only when the weight of the body has fallen to one-half or one-third of its original weight that death from inanition ensues. When dealing with cases of acute disease, when nourishment cannot be administered by the mouth, it is well to remember these facts. According to Hutchison(10), physicians not infrequently may be inclined to flatter themselves that they have kept a patient alive by rectal feeding, when as a matter of fact the patient has been subsisting on the reserve supply which has been stored up for an emergency of this character. He has, indeed, been living on himself or from his own tissues. One need not be unduly alarmed if a well-nourished patient is unable to take any food at all for a few days. The "factor of safety," his reserve supply, discussed on the previous pages on overfeeding, will in a large number of cases be able to tide him over the time of stress without any special injury to his health. An ill-balanced diet is one of the main causes of chronic malnutrition. Nitrogen being the element of which the body is mainly built up, it would seem that a lack of protein in the food would be more injurious than a defi-

cient supply of carbohydrate or fat. The question of the protein intake has been considered in Volume II, Chapter V.

Suffice it then to say, with regard to too small a supply of protein in a diet otherwise sufficient, that, according to Rechenberg(11) and von Noorden, it is certain that in cases where the diet is full a moderate diminution in the protein acts less harmfully than a free supply of protein with a caloric deficit in the dietary. In the latter case, the body goes on losing fat continuously and finally also protein; in the former the loss in protein does not go beyond a certain limit. The protein in requirements may be reduced to a comparatively marked extent without harm; the caloric value of the diet, on the other hand, cannot be lowered, or only very slightly. Von Noorden goes on to say that it is by no means permissible to explain any lowering of nutrition or of muscular strength, such as may occur in certain classes or among people living under unfavorable social conditions, as exclusively brought about by the smallness of the protein intake. Many, perhaps most, observers, do not agree with von Noorden as to this point, and Hutchison expresses the most widely held views when he says that an insufficient supply of protein leads to imperfect tissue repair, more especially, perhaps, of the muscles and blood; that it causes the body to become unduly watery, whence the pallor and puffiness of the underfed; and that the combined effect of these results is to produce a lowering of the power of resistance to unfavorable influences, including disease. A daily ration of which the protein content is greatly below the standard of Chittenden (many are of the opinion that Chittenden's standard is too low), is much more injurious than a shortcoming in respect to carbohydrates and fat.

Maleficent Sequences of Underfeeding.—As the question of underfeeding with its maleficent sequence of untoward effects on body and mind, appears to hinge largely on the quantity of protein in the diet, and, as this is the phase of the subject which has given rise to the most strenuous arguments, protein in its relation to malnutrition, physiologically and pathologically considered, will be amply dealt with later.

However, before going into the question of underfeeding from the more scientific point of view, and before attempting to sift the wheat from the chaff in the dicta of those who have experimented and made observations on the metabolism of underfeeding, it may be interesting and perhaps instructive to discuss these features from a wider aspect. The effects of insufficient and injudicious feeding are manifest on all hands. The mind, the body and, if the term is allowable, the spirit, are injuriously influenced by innutritious and insufficient food. The person

who is ill-fed deteriorates in all respects. Underfeeding is not the sole cause, but it is an extremely powerful contributory cause.

With regard to both *mental and physical deterioration* brought about by an insufficient and ill-balanced food supply, perhaps the most complete and convincing evidence was afforded by reports concerning prison experience in this direction published in 1898 in England. An especial sting was given to these reports, because they were partially confirmed at the time by the gruesome and powerful "Ballad of Reading Gaol," written by that unfortunate genius, Oscar Wilde. The Parliamentary Committee, two of whom were in the prison service, who were appointed to report on the alleged insufficient feeding of prisoners and who were certainly not biased against the existing system, after a searching inquiry stated that the diet was inadequate for the labor on which the prisoners were employed, that the breakfast and supper meals of male convicts were insufficient, while the element of fat in the dietary was deficient and more variety of food was desirable. It will not be contended that the low diet was alone responsible for the breakdown of the health of many prisoners. Other influences conducing to a lowering of physical and perhaps mental resistance must be taken into account, such as the probable physical and mental degeneracy of a large proportion of the inmates, their monotonous and generally unhealthful mode of life, and so on, but it may certainly be asserted that a diet deficient in quantity and lacking certain essential nutritive elements was an important factor in rendering the inmates especially prone to disease. Phthisis in those predisposed to the disease—and according to the most recent views there are few of us who are not thus predisposed—is notorious for attacking those whose vital resistance is weakened; and the records of prisons in which the inmates are habitually underfed fully bear out this universally accepted theory. The tubercle bacillus appears to find a specially favorable soil in ill-nourished individuals and the association between an insufficient diet and such diseases as phthisis and scrofula is so well established that the reiteration of the facts becomes almost tiresome. Perhaps this is why diabetics, who live in state of more or less chronic starvation, are so liable to tuberculosis.

Some few years ago the Rt. Hon. Charles Booth and Mr. Rowntree inquired into and made a report upon the condition of the laboring population of England and found that very considerable numbers of unskilled laborers were poverty stricken and chronically underfed, not perhaps to such an extent as to cause immediate physical suffering from lack of food, but yet enough to diminish working power and to lead ultimately to impairment of health. The power of resistance to infection and to

mental and physical deterioration is sadly impaired in these men and even more in their families, for it cannot be too strongly insisted upon that when a man earns woefully small wages, it is the wife and children who suffer the most, and therefore, in the long run, it is the race and nation who must bear the brunt of underfeeding.

Large sections of the community in all countries are still habitually underfed. America, Canada and Australia compare very favorably with Euopean countries in this respect. The reports from the former lands with regard to the condition of their working population are not as precise or as voluminous as those from Great Britain, and consequently it is to Great Britain that we turn for accurate and full information respecting social, economic and public health conditions.

Observations on the diet of laborers in Edinburgh showed that it contained an average of 107.7 grams, and an energy value of 3,228 calories, as opposed to the 3,500 believed to be necessary for a man doing a moderate amount of muscular work. Mr. Rowntree's inquiries into the diet of a corresponding class in York yielded somewhat similar results, the protein average being no less than 29 per cent below what is or used to be regarded as standard requirements. The Edinburgh investigators (quoted by Hutchison) held the view that in order to improve the dietary of the laboring classes, the following principles should be instilled into them: (*a*) That a diet of tea and bread or of tea, bread and butter is faulty; (*b*) that the faults of the tea and bread diet can be corrected by the free use of meat, eggs, or other animal food, but that this mode of correction is expensive; (*c*) that the faults can also be corrected by the free use of oatmeal with milk, or of peas and beans, without extra cost.

It has been mentioned once or twice before that the worst effects of underfeeding fall on women and children, and it is the children who are the least able to bear deprivation of food, not only from the personal point of view, but also, and this is the most essential feature, from the national outlook. Hippocrates was well aware that the lack of food affected the young most injuriously, as one of his aphorisms runs after this fashion, "Old men bear want of food best; then those that are adults; youths bear it least, most especially children, and of them the most lively are the least capable of enduring it." The young need plenty of nourishing food in order that they may grow up healthy and vigorous, for if a considerable proportion do not have a diet sufficient and well balanced, they, if they survive, will come to maturity stunted in physique. If not actually unhealthy, they will lack vitality and will be rendered peculiarly susceptible to infection, probably deficient in mental attributes and when not

already steeped in crime, at least generally lacking that moral sense which serves as a bulwark against crime. Such as these fill our prisons and asylums; they are a menace to the community, and their very existence approaches a national disaster; they propagate their like and endanger the well-being of a nation. Underfeeding is a prominent factor in their production and development; the remote results from the health aspect can only be touched upon. There is no need to elaborate on the fact already strongly emphasized that underfeeding lays the system open to the inroads of disease.

Investigations of a searching and impartial character have taken place into the condition of elementary school children in various parts of the world, including those attending schools in parts of the Southern States of this country, and deplorable evidences of physical deterioration have been revealed. They provide conclusive proof of the *blighting influence of parsimony in nutrition* while growth is going on, to say nothing of diseases and defects, mental and physical. Unfortunately, this does not only signify a temporary setback, but a lasting damage, for the manner in which a child is fed at the growth period determines all subsequent development. Dwarfing, permanent dwarfing of one kind or another, is the consequence of insufficient feeding in early life.

Reference may be made to the effects of insufficient feeding in *diminishing resistance to cold and exposure.* Sir John Franklin, in describing his and his companions' journeyings in the Arctic regions, said that during the whole of their march they found that no quantity of clothing could keep them warm while they fasted, but on those occasions on which they were enabled to go to bed with full stomachs, they passed the night in a warm and comfortable manner, which signified that the demand for heat in the body was so great that it could no longer be met by diminishing loss, but that the deficit had to be made up by an increase of heat production, that is, by a greater consumption of food.

The influence that inadequate and unsuitable food exerts on the capacity of the system for withstanding the effects of cold was well exemplified by certain episodes of the American Civil War, an account of which has been given by Flint(12).

Chronic underfeeding will sap the vital forces; the powers of resistance of the body will be so undermined that infection will be easily contracted and underfed people will be a danger to their fellowmen inasmuch as they will provide a fertile agency for the spread of infection.

Its effects in producing liability to *disease* were illustrated in a striking way by the outbreaks of relapsing fever and typhus which followed

the potato famine in Ireland in the early part of the nineteenth century. Similar results have been observed to follow in the wake of famine everywhere, notably in India and in China where fever and plague invariably dog the footsteps of famine. It has also been pointed out by Hutchison that exposure to infection is specially apt to be dangerous on an empty stomach, as, for example, before breakfast, a fact which it is particularly important for members of the medical profession to bear in mind.

Enough has been said as to the relationship of underfeeding to disease. The two are most intimately related, and it is an obvious fact that the furnishing of cheap and good food is as much of an economic as it is a hygienic measure.

There is one other phase of the subject in connection with individual and public health that is worthy of brief comment—the bad effect of chronic underfeeding on the *digestive organs.* In all cases of chronic underfeeding an impairment of organs concerned with the digestive process is observed. The truth of this statement may be partly verified in the case of dyspeptics. The less they eat the less they are able to digest and the more their nutrition fails. Frequently the most effective mode of curing their stomach troubles is to insist that they eat more. Unfortunately, so far as the poor are concerned, this remedy is impossible. But it is an interesting question whether the effect of town life, combined with poverty or merely ignorance or carelessness in impairing digestive power, may not be to a certain extent responsible for the habitual underfeeding so often found in the industrial section of urban districts. In other words, they may be instances of both cause and effect. A vicious circle has been established, and the town worker even when comparatively well-to-do may in many cases be incapable of digesting enough food to keep him in an ideal state of physical efficiency. This fact was forcibly emphasized in the early part of 1917 when the author was mustering officers for several National Guard regiments, passing on their fitness to enter the Federal service. It was observed that one-third of the young men coming from the industrial centers showed evidences of underfeeding. They were 33 per cent undersized, underfed and underweight.

Diverging somewhat from the subject in hand, may not underfeeding also be a potent *cause of drinking?* The underfed man, even if he be poor, feels the want of some stimulating or perhaps narcotic action and he seeks and finds this spur or Lethe in alcohol. There is a definite relationship between underfeeding and the consumption of alcohol.

Undoubtedly there is a close connection between *underfeeding and*

crime. The underfed individual, especially if he or she has been underfed from childhood up, is a potential criminal. Again it may be said that there is no intention to aver that lack of food is the sole cause of crime, but, on the other hand, it is an always present spur to crime. Poverty and underfeeding are debasing influences, morally, physically and mentally, and in the words of Dr. King Chambers(13), "deficient diet, like all morbid conditions, both corporeal and mental, is a vitiating and degenerating influence. Famine is naturally the mother of crimes and vices, not only of such sort as will satiate the gnawing desire for food, but of general violence and lawlessness, ill temper, avarice, lust and cruelty."

Underfeeding if not *the mother of crime* is at least a very near relation, and if a nation is to be happy and prosperous it is a paramount necessity that its members shall be well fed. Ignorance has much to do with underfeeding, and in order to inculcate into the minds of the mass of the people some elementary truths concerning food values, a campaign of education should be inaugurated on these lines in every civilized country. This has been done in the large industrial centers of Great Britain and in some of the European countries. The Mothers' Welfare Associations, which have sprung up throughout the urban communities of Great Britain, due to the initiative of Dr. Eric Pritchard of London, teach mothers how to feed and bring up their babies and also how to feed and bring up their families, including their husbands. With regard to food values, absolutely exact and definite knowledge is still lacking, but quite enough is known to enable us to lay down rules as to the most nutritious and suitable foods for all sorts and conditions of men living in all sorts of conditions and in any climate.

Metabolism of Underfeeding.—Some of the recent views dealing with the metabolism of underfeeding will now be presented.

PROTEIN METABOLISM.—*Minimum Protein Necessary to Maintain Nitrogen Equilibrium.*—Views as to protein metabolism are conflicting, especially with regard to the question of how much protein is necessary to maintain health, or, in other words, to maintain nitrogen equilibrium. The opinions of von Noorden and Rechenberg on this much vexed point have been stated, and the following (taken from von Noorden) is a table in which certain experiments in this direction are noted:

TABLE SHOWING THE NECESSARY PROTEIN MINIMUM FOR BODY WEIGHT

Authors	Weight without Clothes Kg.	Gross Intake: Calories, Total	Gross Intake: Calories, Per Kg.	Gross Intake: Nitrogen, Gms.	Gross Intake: Protein, Gms.	Gross Intake: Protein per Kilo, Gms.	Result	Duration of Experiments in Days	Remarks
I. Klemperer (*a*).........	64.0	5020	80	5.28	33	0.5	After 3 days N equilibrium	8	
" (*b*).........	65.0	5020	80	5.28	33	0.5	" 2 " " "	8	
Caspari and Glaessner (*a*)	69.0	4559	66	7.83	49	0.71	From the outset N retention	5	Vegetarian
" " " (*b*)	58.0	2715	47	5.53	33	0.58	" " " " "	5	Female vegetarian
Rumpf and Schumm...	63.4	3432	54	11.8	74	1.15	" " " " " (daily +0.9 gm.)	8	" "
Kumagawa...........	48.8	2478	52	8.75	55	1.14	N retained	9	Japanese diet
Peschel.............	circum. 75.0	3700	50	6.9	43	0.58	Only at the end retained	8	
II. C. Voit and Constantinidi	57.0	2710	48	8.4	54	0.95	....	13	Vegetarian
Hirschfield...........	73.0	3462	47	7.44	46	.06	Only at the end N retained	8	
Breisacher............	57.1	2866	45	10.8	67	1.19	N of feces not estimated. Urine N remained 2 gm. below food N; certainly, therefore, N equilibrium was attained.	30	
III. Siven................	59.0	2477	42	6.26	39	0.66	N equilibrium	6	
Lapicque (*a*)..........	73.0	3027	41	8.8	55	0.76	N retained (0.5 per day)	8	
" (*b*)..........	65.8	2728	41	8.8	55	0.84	Small N losses	8	
R. O. Neumann.......	66.2	2659	40	12.2	76	1.1	Gain in N and body-weight	13	
Albu.................	37.5	1400	37.3	5.46	34	0.9	Small gain in N	5	Female vegetarian very small and thin
Chittenden (*a*)........	57.5	1613	28	6.40	40	0.7	Daily +0.165 gm. N	6	
" (*b*)........	57.5	1549	27	5.86	37	0.64	" —0.07 " "	6	

NOTE I. Collecting the results shown in the above table the respective intakes were as follows:

0.5—.6 gram protein per kilo	Klemperer, Peschel and Glaessner (b)
0.6—.7 " " "	Hirschfield, Chittenden (b), Siven
0.7—.8 " " "	Chittenden (a), Caspari and Glaessner (a), Lapicque (a)
0.8—.9 " " "	Lapicque (b)
0.9—1.0 " " "	Albu, Voit and Constantinidi
1.1—1.2 grams " "	Neumann, Rumpf, and Schumm, Breisacher

Von Noorden hedges somewhat with regard to the intake of protein necessary to maintain health and the nitrogen equilibrium by giving, as his opinion, that in spite of the teaching of Chittenden and others their doctrines will not attract too many admirers, nor will these doctrines bring them many adherents, for the majority of men even with the alluring prospect of a prolongation of life or rejuvenation prefer to enjoy the comforts of this mundane sojourn.

The workman will still take a larger quantity of meat than the sedentary man. More protein is always taken during severe muscular work, and there must be a good reason for this. The Vienna scientist then proceeds to dissect the explanation brought forward by Voit and finishes by saying that while it is certainly true that, in passing to a diet poor in protein, the body loses nitrogen at the outset, nevertheless the total loss is small, and the functional capabilities may not be at all diminished. If the musculature is kept in good condition by continual exercise, even if the diet is lowered to less than two-thirds of Voit's standard, muscular strength and power of carrying out work may be actually increased. Von Noorden may be, therefore, taken as an advocate of a low protein intake.

E. T. Spriggs(14), the British authority, who has given the question of diet the most thorough experimental study, sums up the relation of protein to activity by saying that the bulk of the caloric value required for muscular work should be supplied by carbohydrate or fat, but that it is an advantage also to increase the protein in food, and that a diet containing a fair amount of protein is likely to be favorable to an energetic existence.

Another English authority, Sir James Crichton Browne(15), has pointed out that even if it should be fully established by experiments more extended and varied than those of Chittenden, that nitrogen equilibrium can be maintained on a much smaller amount of protein than has hitherto been supposed, there would still be a question as to whether it would be wise and prudent to adopt the minimum amount as the rule of life. With a low protein supply the organism may have to adapt itself to its situation under conditions of strain. It has a large power of adapting itself to circumstances, but that power may be overtaxed. Let it be granted that the average amount of protein food now habitually ingested does considerably exceed the quantity required to maintain at an exact point metabolic equilibrium, it does not follow that it should be lowered to the point at which, according to laboratory observations, metabolic equilibrium stands steady. Metabolic equilibrium is never

steady or at a fixed point. It varies in different individuals and in the same individuals from hour to hour, and it is always safe to allow a margin, and a broad margin.

This writer contends that not only is protein starvation manifested in diminished resistance to bacterial invasion, but in a general lowering of bodily tone, and in debility which may be traced to diminished metabolism, owing to the withdrawal of the stimulus to it which alimentary principles of the protein class supply. Benedict(16), too, traverses Chittenden's results and concludes that permanent reductions of protein intake are decidedly disadvantageous, and not without possible danger. The relationship of a small protein intake, then, to underfeeding has been by no means made clear. Some assert and seem to have proved their assertion by careful experiments that a low protein intake has little to do with underfeeding. At least they state that a man can thrive and perform really hard labor on a diet the protein constituent of which would have been regarded only a few years ago as ridiculously inadequate. Others hold that, while most people were and are accustomed to ingest too much protein, the standard laid down by Chittenden and those who hold his views is too low. Still others, like Sir J. Crichton Browne, claim that a very considerable protein intake is necessary for the conservation of good health, and especially in the case of laborers and those who take a good deal of heavy exercise.

The author is among those who are not extremists and is of the opinion that a fair amount of protein should be taken by persons who perform manual labor and carry on their work in the open air. Therefore, a small protein intake is a factor of some moment so far as underfeeding is concerned. Underfeeding in the ordinary circumstances of life occurs, as a rule, from an insufficiency of nitrogen-free substances, generally associated with a diminution of protein.

In all cases in which underfeeding is persisted in for long periods, it is associated with a smaller or greater loss of protein. Hirschfield (17), Kumagawa(18), R. O. Neumann(19).

Neumann supplies the best example commencing with an insufficient diet. He very gradually raised the protein and energy intake until he arrived at nitrogen equilibrium. For thirty-five days or longer he kept on the insufficient diet.

The following table, taken from von Noorden, showed the conditions that existed:

TABLE SHOWING EFFECT OF INSUFFICIENT DIET WITH GRADUAL INCREASE IN ALIMENT UNTIL NITROGEN EQUILIBRIUM WAS ESTABLISHED

Series	Duration in Days	Intake			Cal. per Kg.	Nitrogen Balance		Difference in Weight	Weight at Outset, Kilo.
		N	Protein	Cal.		Daily	Of the Whole Series		
1	10	8.02	51	1,535	23	−2.81	−28.1	+0.0	67.0
2	12	9.07	57	1,599	24	−3.11	−37.3	−0.9	67.0
3	8	11.24	70	1,909	29	−2.11	−16.9 −96.1	−0.1 −1.5	66.1
4	5	12.70	79	1,937	30	−2.76	−13.8	−0.5	66.0
5	15	12.23	76	2,659	40	+0.22	+ 3.3	+1.3	65.5
									66.8
Average	50	10.56	..	1,987	30	..	−92.8 (!)	−0.2 (!)	66.1

The striking fact to be gathered from Neumann's experiments is that in the fifty days, with an average intake of 10.56 grams nitrogen and 1,987 calories, he lost 93 grams nitrogen, and at the same time showed a loss of only 2 kilograms in body weight.

The next table shows a series of experiments exhibiting the different amounts of protein requisite for the organism, as well as for the energy intake. G. Renvall(20), the results of whose experiments are here given, had a different end in view from Neumann, but used the same methods to carry out his experiments. His experiment was also of long duration:

TABLE SHOWING EFFECT OF INSUFFICIENT DIET GRADUALLY INCREASED UNTIL BROUGHT UP TO BODY REQUIREMENTS[1]

Series	Duration in Days	Intake			Nitrogen Balance		Difference in Weight, Kg.	Weight Kg.
		N	Cal.	Cal. per Kg.	Daily	Of the Whole Series		
1	8	12.1	2,062	29	−5.34	−42.7	−1.5	71.1
2	7	13.7	2,617	37	−2.66	−18.6	−2.0	69.6
3	6	16.1	2,843	42	−2.74	−16.4	−0.4	67.6
4	5	22.7	3,783	56	0.14	0.7	−0.0	67.2
5	3	21.2	3,577	53	−2.47	−14.8	−0.0	67.2
..	..	..	..	..	..	..	..	67.2
Average	32	16.5	2,889	46.2	−2.9	−91.8	−3.9	68.2

[1] Taken from von Noorden.

Neumann and Renvall each lost about 92 to 93 grams nitrogen in five to seven weeks, the former on a diet which would be considered barely sufficient under most circumstances, the latter upon one which would certainly be regarded as rich, and yet the former maintained his weight almost unaltered. According to von Noorden, he must have stored water, because in his opinion he could not have stored before the beginning of the experiment quantities of intracellular protein to account for so slight a loss of weight. Renvall lost flesh, some water and probably fat.

In the table on the opposite page (taken from von Noorden) are included other series of experiments.

All the experiments noted in the above table were carried out on the investigators themselves, who were working under practically identical conditions. The difference in the amount of nitrogen and in the protein and energy intake necessary to maintain equilibrium is remarkable and goes to show how greatly such variable results are due to the individual organism.

Chemical Decomposition of Protein Tissue.—It used to be the almost invariable custom to regard every sign of protein breaking down in disease as dangerous, and protein decomposition in the tissues as the origin of all grave symptoms. As a matter of fact, protein breaking down in disease is still looked upon as menacing. Von Noorden, however, thinks that in many cases this is a false conception. He is also of the opinion that the significance which is often attached to the products of the chemical decomposition of tissue protein is erroneous. There is no space to deal with the German authority's arguments against these long held beliefs, and it will be sufficient to say that in his opinion the strongest evidence against the doctrine that protein losses constitute a grave menace in disease is that in the most perfect health tissue protein breaks down.

Pathology of Metabolism of Starvation.—It is very evident that a knowledge of the metabolism during fasting is of the first importance from the outlook of physiology and pathology. Experiments upon fasting animals and men have brought out many momentous facts, while pathology has to do with diseased persons who are starving or nearly so. There are two kinds of fasting: acute starvation and chronic starvation or malnutrition. The former type has been most extensively studied, but the pathology of its metabolism is still incomplete.

To deal with the pathology of metabolism of starvation or chronic malnutrition exhaustively would take more space than can be given to it in this work. Nor, perhaps, would much be gained by so doing, since opinions on some of the more important points have not crystallized, and

SIVEN'S TABLE SHOWING GRADUAL RISE IN PROTEIN INTAKE BUT WITH A CONSTANT AND SUFFICIENT ENERGY INTAKE

No. Series	Author	Duration in Days	Average Intake: Nitrogen	Average Intake: Total Calories	Average Intake: Calories per Kg.	Nitrogen Balance: Daily	Nitrogen Balance: In the Whole Series	Nitrogen Balance: Loss of the Amount Stored	Average Weight in Kg.	Period
1	Neumann, I....	50	10.56	1,987	30.0	−1.85	−92.8	−0.2	66.1	March to May
2	Renvall........	32	16.5	2,889	42.6	−2.9	−91.8	−3.9	68.2	Oct. to Nov.
3	Siven, II.......	33	8.3	2,650	41.0	−0.35	−11.7	−1.6	64.7 (65.4–63.8)	(?)
4	Siven, I........	39	7.9	2,400–2,500	41.0	+0.27	+10.6	−2.8	59.4 (60.8–58.0)	(?)
5	Clopatt........	36	16.2	2,527	34.0	+0.5	+17.3	−4.1	74.4	April to May
6	Rosemann, I...	29	16.3–17.1	3,325	41.6	+0.95	+27.8	−1.6	80.0 (80.8–79.2)	March
7	Rosemann, II..	24	11.7–13.5	2,966	37.1	−1.0	−23.3	−3.5	81.0 (82.5–79.0)	October
8	Neumann, II...	35	12.2	2,638	39.0	−0.6	−20.3	−0.1	65.5 (68.5–68.6)	
9	Neumann, III..	36	18.0	2,958	41.0	+0.84	+30.4	+0.4	72.5 (72.3–72.7)	
10	Neumann, IV..	24	12.2	2,638	39.0	+0.18	+ 4.3	+0.0	68.5	
11	Neumann, V...	24	14.2	2,357	33.0	+0.0	+ 6.0	+0.15	71.5–71.65	

Nos. 1 to 4: Variable amounts of nitrogen in the diet; in Nos. 1 and 2 (?) with sufficient caloric intake, in Nos. 3 and 4 with sufficient caloric intake.

No. 1: Experiment with an insufficient nitrogen and caloric intake at the beginning. At the beginning nitrogen losses, at the end a slight gain in nitrogen.

No. 2: Similar to No. 1.

No. 3: Sufficient caloric intake throughout. Nitrogen intake at outset insufficient, rising to a free supply. At the beginning loss in nitrogen, at the end a gain.

No. 4: Sufficient caloric intake throughout. Nitrogen intake falling from a sufficient amount. In the beginning a gain in nitrogen, later a loss.

Nos. 5 to 10: During the whole course of the experiment an almost constant caloric intake.

Nos. 5, 6, 7, 8, 9: An alcohol series occurs in the middle of the whole investigation.

No. 10: Experiment with varying quantities of water (immediately following No. 8 in time).

No. 11: Experiment with myogen.

As a matter of fact, the nitrogen balance in all experiments is rather more unfavorable (to the extent of some grams) than the numbers shown in the table. In no case was the loss of the skin estimated, and this would amount at the least to 0.3 grams daily; the excretion of a thirty to fifty days' series requires an addition of at least 10 to 15 grams.

experiments on chronic malnutrition have been inadequate for many obvious reasons. The object of this treatise will be to discuss some of the more salient points in regard to the subject.

As to the consumption of energy on the complete withdrawal of food during the first days, according to most authorities, the general metabolism suffers no diminution. The sum of the investigations gathered from experiments on fasting men give general values of 22 to 25 calories per kilogram per day as the mean minimum conversion of energy while fasting during complete bodily rest. The expenditure of energy during starvation diminished in the same proportion as the weight of the body. The fasting man lives upon protein and fat, except during the first few days, while his muscles and liver still contain glycogen. The respiratory quotient at times fell below the theoretical minimum 0.7.

Pembrey and Spriggs(21) record that in rats, during fasting, the respiratory exchange quickly reaches a minimum, and remains almost constant during the prolongation of the fast.

CONSUMPTION OF ENERGY IN CHRONIC MALNUTRITION.—With regard to consumption of energy in chronic malnutrition, experiments are few and inconclusive. It seems that certain individuals are able to exist with a particularly low consumption of energy. Von Noorden believes that even in chronic malnutrition, the minimum amount of energy required by persons who are bedridden or who are indoors and do little bodily work does not fall below 30 to 32 calories per day per kilogram.

The following are Rubner's figures for a dog whose consumption of energy was investigated for three years:

TABLE SHOWING DIMINISHING CONVERSION OF CALORIES PER KILOGRAM ACCOMPANYING PROGRESSIVE LOSS OF FLESH

Variations in Weight, Kilogram	Mean Weight, Kilogram	Average Conversion of Calories	Average Conversion of Calories per Kilogram
8.01–6.84	6.94	432.1	62.3
6.66–6.33	6.45	371.8	57.6
6.27–5.80	6.09	332.0	54.7

PROTEIN METABOLISM IN ACUTE STARVATION.—The protein metabolism of man during acute starvation has often been investigated. Fasting persons habitually drink water in small quantities. After the first day, or perhaps after the first two days, the standard loss of nitrogen

may be taken as 10 to 13 grams for the next week or ten days. The loss of nitrogen according to Pransintz(22) is relatively greater in the thin than in the fat. The nitrogen excretion of fasting women is from 20 to 30 per cent less than that of fasting men. The protein decomposition is relatively large at first, and usually sinks somewhat sharply as the starvation proceeds.

Figures show how the organism spares its protein when it is ill fed. Chronic malnutrition is not characterized by a small nitrogen excretion, but the output of nitrogen depends essentially upon the preceding diet. In chronic malnutrition but little urinary nitrogen is usually found. Von Noorden is not an advocate of protein feeding and claims that protein cannot prevent the loss of power in underfed people and he concludes that in heat-value starvation a protein-rich diet does not protect the tissue protein from being consumed. According to von Noorden our present knowledge of the decomposition of protein in chronic underfeeding is as follows:

1. After prolonged malnutrition the decomposition of protein is gradually lessened; more of the tissue protein is lost in the earlier than in the later stages. Analogous are cases where the demand for heat is met fully while only the protein intake fails to reach the required level. Loss of the body protein does not necessarily follow in such cases. Nitrogen equilibrium can be maintained upon a protein decomposition far smaller than that which usually obtains, as, for instance, on a daily excretion of from 6 to 10 grams of nitrogen in the urine and feces. But generally it is only weak persons who illustrate this possibility, and the question may properly be asked whether a larger protein intake would not bring them more nearly to their optimum of nutrition and strength.

2. Long continued underfeeding, apart, perhaps, from minute and hitherto unproven degrees of caloric deficiency, invariably leads to loss of body fat as well as to loss of tissue protein, whether the supply of food protein is large or small. Only the absolute extent of nitrogen excreted varies with the latter factor; the establishment of a nitrogen balance is independent of its duration. A diet of low heat value but rich in protein can diminish, or even for a time postpone, the loss of nitrogen, but in the long run the result for human beings will be the same as if all the components of the diet were diminished. If the heat value of the food be continuously inadequate, an increase of protein will perhaps put a stop to the loss of nitrogen from the body for the time being, but, in man, a moment comes when further increase of the food protein in the diet becomes impracticable. In these circumstances the tissue protein

can only be maintained by adding nitrogen-free constituents to the diet in order to satisfy the demand for heat.

3. At present no exact quantitative measurements of the relations between the caloric deficit and the loss of body protein in chronic underfeeding are extant. The loss is unexpectedly small in some cases, in others surprisingly large.

4. Whenever a poorly nourished individual receives an increased amount of food, so that the deficiency of heat is decreased, an effort is made to retain nitrogen and repair the loss of cellular material that has occurred. This retention of nitrogen goes on until the body has readjusted itself to its new conditions of nutrition. Then the loss of nitrogen begins anew unless the calories required have been adequately supplied. The influence of starvation or chronic malnutrition upon the digestive organs is that their activity is lowered although not uniformly. Malnutrition leading to extreme loss of body weight does not invariably stop the production of hydrochloric acid.

SECRETION OF BILE.—There is less secretion of bile during fasting than when the diet is full, but it is never entirely absent. The quantity of bile secreted is diminished but it is usually more concentrated. The glycogen in the liver is consumed rapidly, at first, but more slowly as the fasting continues. F. Muller(23) found that during starvation the feces contained hardly any soluble protein, but a relatively large proportion of nuclein. The excretion of fat amounted to 1.21, 0.57, and 1.14 grams a day. About half consisted of neutral fats and cholesterin, the other half being composed of free fatty acids and soaps. The absorbing power of the intestine, according to many German authorities, does not diminish in consequence of prolonged malnutrition. This is an important point with regard to dietetic treatment in connection with the evacuation of feces. A certain amount of putrefaction is said to go on in the intestine during the withdrawal of food despite the fact that no protein reaches the intestine.

THE BLOOD.—In chronic malnutrition the percentage of water in the blood is maintained approximately at the normal level.

During starvation the leukocytes are diminished in number.

THE URINE.—During starvation the average amount of urine remains sub-normal. In cases of chronic underfeeding the conditions vary greatly so that no fixed rules can be laid down.

During acute starvation protein is often found in the urine, though mostly in minute quantities. Clinical experience shows that a moderate degree of chronic underfeeding does not commonly lead to the appearance

of more albumin in the urine than may be present normally. The case is altogether different when marked and protracted malnutrition is met with. In such instances, albuminuria, transient or lasting, is the rule. Mild glycosuria has been observed in a few fasting experiments and chronic underfeeding but is probably not directly responsible for any form of diabetes.

Conclusions.—The above brief review of the metabolism and pathological metabolism of starvation and chronic underfeeding is necessarily incomplete and does not profess, as stated in the introductory remarks, to do more than give a few of the more important facts. From the experimental aspect of underfeeding, no very definite conclusions can be drawn, that is, conclusions of practical value. Among those who have studied the matter in laboratories somewhat wide difference of opinion exists with regard to important points. Animal experimentation is fallacious, or at any rate not to be entirely depended upon in drawing conclusions applicable to man. Experiments on those in a condition of chronic underfeeding are few and far between except in cases of disease, in which conditions are not analogous. Fasting experiments are valuable, but a person fasting is not in the same condition as one who is chronically underfed and consequently experiments as to metabolism on fasting persons are not wholly reliable.

It is true that the application of the experimental method has yielded and will yield, as science progresses, some insight into the general principles which govern the nutrition of the body.

Upon food depends not only life itself, but the power to work and to resist disease. An ill-fed people are a backward people, and an unhealthy and a degenerate people. From the vegetable world innumerable examples can be gathered to illustrate the great effect of food variations upon growth and development. In a good soil a plant will evolve in a marvelous manner. On the other hand, a bad soil will yield a poor growth. The most striking example of the effect of food upon development in the animal world is afforded by the queen bee, which grows from a larva in all respects similarly to the working bee, but owes her superior growth to the fact that, different from the rank and file of the bee tribe, she is assiduously fed on a rich diet.

There are two or three points which the author desires to emphasize with regard to underfeeding. The first is that chronic underfeeding is prevalent even in this country and that it is more due to ignorance than to poverty. The poor do not know anything about food values and, more often than not, buy foods which constitute not only a comparatively

innutritious but an ill-balanced diet. Education is needed in this direction.

Another point is that scientific experiments cannot wholly determine food values. In the experience of mankind with regard to diet, there are spread out before us the results of the experiments of ages, and we must be quite as greatly influenced by such experiments as by laboratory investigations. The experiments of ages have demonstrated that man can live a healthy life under dietetic conditions of great variety. It is not wise to be bound by the teachings of one system or another. By studying in an open-minded manner the teachings of experience together with the results of scientific experiments, we shall be able to formulate dietaries suitable for conditions of health and disease. It is with these principles that the problem of underfeeding should be met.

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CHAPTER VII

PROTEIN AND NUTRITION

The discovery of a new dish does more for the happiness of humankind than the discovery of a new star.

Nature of Protein; The Protein Poison.

Metabolism of Protein: Deaminization of Proteins in Amino-Acids; Catabolism of Proteins.

Effect of Protein Diet on Health and Endurance: High Protein Diet; Low Protein Diet; Chittenden's Investigations, Fisher's Investigations, Baeltz's Investigations among Japanese, Other Foreign Nations Non-Meat Eaters.

Standard of Protein Requirement in Dietary.

High versus Low Protein Diet: Protein Diet and the Nitrogen Equilibrium; Reduction of Protein Diet Necessary; Effect of Increased Nitrogen Diet on the Kidneys; Effect of Protein Diet on Strength and Endurance; Effect of Low Protein Diet on Animals; Protein Diet and Occupation; The Amino-Acid in Animal and Vegetable Proteins; Minimum Protein Requirement to Maintain Nitrogen Equilibrium; Safety Standard in Diet: Caution as to Protein Deficiency, Overfeeding, Underfeeding, Ill-Effects of Absorption of End-Products of Protein Digestion.

Protein Structure and Properties: Chemical Formation of the Protein Fractions; Quantitative Differences of Proteins, Qualitative Variations in the Amino-Acids of Proteins; Physical Properties of Proteins; Relative Absorption of Proteins; Differences in Suitability for Tissue Construction.

Theories of Protein Metabolism.

Nature of Protein.—During the past few years a revolution has taken place in our conception of protein metabolism, and we should all be proud of the fact that our own country has furnished its full quota of newly discovered facts upon which our present knowledge is based.

While studying the physiology of digestion (*see* Volume I, Chapter VII), we learned that, among the building material employed for the construction of the living organism, the proteins hold a place apart, and we also learned that protein is absorbed only after being largely or completely broken down in amino-acids, which are then rebuilt into the protein organism.

The conception of the structure of a protein molecule is of special importance not only in the study of protein metabolism, for which we are to use it here, but also in enabling us to grasp the almost unthinkable varieties in which protein exists, without there being, in many instances, any outward chemical reaction or physical property by which one protein can be distinguished from another. It is interesting to note, however, that differences in structure which are too slight to be recognizable by any ordinary chemical tests may become very apparent upon minute biological examination when we proceed to observe the behavior of an animal into whose blood some of the protein is directly injected. It is a well-known fact that symptoms of varying severity develop, from the almost instantaneous death produced by snake venom to the slowly developing anaphylactic reactions which follow the injections into the blood of many proteins that are chemically indistinguishable from those of the blood itself.

The Protein Poison (Protein Absorption).—Vaughan and Wheeler in 1903 found that the cellular substance of the colon bacillus(1) contains a highly active poison and that a closely related or similar poison could be obtained from other pathogenic and non-pathogenic bacteria and from vegetable and animal proteins. It is not found in gelatin. The symptoms induced by this poison in guinea pigs are, *first*, peripheral irritation, such as an urticarial rash; *second* stage, partial paralysis, with rapid and shallow breathing, and, *third* or convulsive stage, that which begins as isolated clonic movements and finally becomes general, involving all the muscles of the body; with fatal doses there is a progressive fall of temperature. Kemp(2) points out that small doses administered subcutaneously in animals produce fever and that various types of fever may be stimulated by varying the size of the dose and the intervals of administration. When proteins are acted on by the digestive juices, the product becomes poisonous at the peptone stage, and if it were so absorbed into the circulation, it would be highly injurious, but with normal digestion the peptone is broken up into harmless amino-acids. If proteins, however, enter the blood without being properly changed by the action of the digestive juices, then they must be digested in the blood and tissues (parenteral digestion), and during the process the protein poison is set free and exerts its deleterious effects on the body. It is suspected by some that protein has an influence in the production of the summer diarrheas of infancy, and studies of the protein poison and protein sensitization have demonstrated how the protein element of bacteria influences the nature and progress of the infectious diseases.

Special idiosyncrasies to certain foods may be explained on the above-mentioned grounds, as, for example, urticaria, presenting the aspect of anaphylaxis from absorption of protein. In certain conditions, at least, protein absorption with *parenteral* digestion is a cause of protein poisoning.

METABOLISM OF PROTEIN

Deaminization of Proteins in Amino-Acids.—According to E. E. Smith, who has given the subject most careful study, the simple amino-acids(3) formed in the intestinal tract from protein breakdown, so far as we know, are absorbed as such and carried through the blood stream to the various tissues of the body, where they meet their fate. They are not absorbed with the same readiness, but there is apparently a decided selective action, both as to the particular amino-acids absorbed and as to the quantity. When they reach the tissues there is a recombination not to form the protein originally ingested, but rather to form the proteins of the particular tissues. Protein resynthesis, not in absorption, but by the individual tissues to which the amino-acids are brought by the blood stream, must be regarded as sufficiently established to be accepted as a working hypothesis. In this way a certain portion of the absorbed amino-acids is utilized. A certain other, and usually a relatively large, portion, not needed for protein resynthesis, undergoes a different change. Instead of entering into constructive metabolic processes, it undergoes catabolic transformations.

Catabolism of Proteins.—When proteins are introduced directly into the blood, parenterally, as we say, they act as a foreign substance and may be eliminated more or less unchanged by the kidneys, giving rise to albuminuria; may pass into the bile, thereby reaching the intestinal tract, where they are digested; may pass directly into the alimentary tract through the intestinal walls; or finally may be split by enzymes elaborated by body cells.

Sensitization to a given protein is developed as the result of the introduction of the protein into the blood and is specific to each protein. When it has once been developed, the subsequent introduction of the particular protein into the system is followed by the phenomenon of anaphylaxis.

EFFECT OF PROTEIN DIET ON HEALTH AND ENDURANCE

High Protein Diet.—In overfeeding of a particular protein, a condition may be produced that is entirely similar to the protein sensitization

that follows the introduction of protein parenterally. Perhaps this has been most clearly observed in the forced feeding of eggs, especially to the young, though it is not uncommonly seen with a particular form of fish feeding, notably shellfish. Frequently, too, this has been observed with meats, and least commonly with vegetable proteins, presumably because of the less concentrated form of the latter and their slower transformation into soluble protein in digestion, though in individual instances particular vegetable proteins have produced the condition to a marked degree. Probably few physicians have failed to recognize at least some of the more marked cases of this kind, and probably few have often failed to overlook most of the less marked cases.

Following an instance or period of overfeeding, there appears a condition of intolerance to the protein in question, which is manifest when the particular protein is again ingested by certain rapidly developing symptoms, perhaps the most constant of which is an urticaria, apt to be generalized in extent with intense itching, frequently dyspnea, sometimes muscular incoördination and often symptoms of gastro-intestinal irritation. It is probable that angioneurotic edema is in some instances, at least, a manifestation of protein sensitization. It is a question for consideration to what extent active protein is the absorbed material and to what extent the protein is absorbed as proteose. Where the urine shows the elimination of unchanged protein, we may well believe that the offending material is native protein; and where the urine is found to contain the foreign protein as proteose, we must at least give serious consideration to the possibility of the protein having been absorbed as proteose, though even there it must be recognized that the native protein may have been transformed into protein after absorption, since it is the tendency of the tissues to bring about this change.

We may well question whether urticaria following food ingestion is always to be regarded as an anaphylactic manifestation or whether it is not at times produced by a different type of gastro-intestinal toxemia. When, for example, we regard the toxemia following the ingestion of strawberries, we have a condition well explained from most points of view by the theory of protein sensitization; but we have to face the fact that strawberries are not rich in protein and that, therefore, the sensitization, if present, has been produced without rich protein ingestion. Evidently some further knowledge is required before the pathology of susceptibility to strawberries can be unequivocally regarded as coming within this category.

Recently, the theory of protein sensitization has attracted attention

and in some instances is charged with the faults that have heretofore been explained by chronic intestinal toxemia of bacterial origin. It is a matter for the future to decide to what extent toxic manifestations are to be referred to the absorption of proteins, to products of bacterial synthesis of the digestive products of food proteins. At the present time the evidence already at hand as to the part played by bacterial decomposition is not to be ignored(4).

Low Protein Diet.—CHITTENDEN'S INVESTIGATIONS.—Prof. Chittenden, of Yale University, in November, 1902, began an experiment upon himself which he has recorded. At this time he was forty-seven years of age and weighed 143 pounds(5). He says that, accustomed to eating daily an amount of food approximately equal to the prevailing dietary standards, he recognized that his habits of living should not be too suddenly changed, so a gradual reduction was brought about in the amount of protein or albuminous foods he was accustomed to ingest. Within the course of a month or two this gradual decrease in proteins reached complete abolition of breakfast, except for a small cup of coffee. A light lunch was partaken of at the noon hour, followed by a heavier dinner in the early evening. Occasionally, however, the heartier meal was partaken of at the noon hour, as his appetite suggested. It should be added that the total intake of food was gradually diminished, as well as the protein constituents. There was not, however, a change to a vegetable diet, but a simple introduction of physiological economy. The goal to which his attention was directed was the exclusion of meat in some measure, the appetite not calling for this form of food in the same degree as formerly.

At the beginning, he confesses that this change to a smaller amount of food daily was attended with some discomfort, but gradually passed away, and his interest in the subject was increased by the discovery that he was unquestionably in improved physical condition. A rheumatic trouble in the knee joint, which had persisted for a year and a half, and which only partially responded to treatment, entirely disappeared. Minor troubles, such as sick headaches and bilious attacks, no longer annoyed him periodically, as in the past. He experienced greater appreciation of such food as was eaten and possessed a keener appetite. A more acute taste appeared to be developed and a more thorough liking for simple foods. According to his report, by June, 1903, his body weight had fallen to about 128 pounds.

In speaking further of his experience, he says that during this summer the same simple diet was adhered to: a small cup of coffee for breakfast, a fairly substantial dinner at midday, and a light supper at

night. The next two months he spent at a fishing resort in northern Maine. Part of the time he dispensed with a guide and rowed his own boat, frequently six to ten miles in the forenoon (against head winds), without breakfast, and with much greater freedom from fatigue and muscular soreness than previously on a fuller protein dietary. On his return home he weighed 127 pounds. From July 1st he remained constantly at this point, at which it would seem that the body had found and maintained its equilibrium. In order to determine his nitrogen equilibrium, he collected each day's output of urine for a period of eight and a half months. The urine was analyzed every day and the contained amounts of nitrogen, uric acid and phosphoric acid recorded.

The daily average was as follows: from October 13, 1903, to March 12, 1904, the average volume of urine excreted was 468 grams; the nitrogen content was 5.69 grams; uric acid, 0.392 gram, and phosphoric acid, 0.904 gram. It will be observed that the volume of urine excreted was small, though fairly constant for the whole period. The explanation offered is that on a low intake of protein there is less thirst and less desire to drink. When nitrogenous waste is reduced to a minimum there is no need on the part of the body for any large amount of fluid to flush out the kidneys, while with heavier eating—partaking of highly nitrogenous foods—an abundance of water is necessary to prevent the kidneys from becoming clogged, thereby explaining the frequent beneficial results of the copious drinking of mineral waters, spring waters, etc., frequently called for after or with heavy eating. It is obvious, therefore, that a small volume of urine each day means so much less wear and tear of the delicate mechanism of the kidneys. The low nitrogen output of only 5.69 grams, equal to 35.56 grams of decomposed protein, is very remarkable. Prof. Chittenden affirms that there could be little doubt that his body was in nitrogen equilibrium and that his body weight was constant during the whole period. Chittenden, in summing up his observations, says(6):

> Health, strength, mental and physical vigor, have been maintained unimpaired, and there is a growing conviction that in many ways there is a distinct improvement in both the physical and mental condition. Greater freedom from fatigue, greater aptitude for work, greater freedom from minor ailments, have gradually become associated to the writer's mind with this lowered protein metabolism and general condition of physiological economy.

Chittenden was fully alive to the necessity of caution in the acceptance of his feelings as a measure of physical or mental condition, but he was keenly watchful for any sign or symptom during the course of his

experiments, and is still strongly of the opinion that there is much good to be gained in the adoption of dietetic habits that accord more closely with the true physiological needs of the body. Thus he asks:

> If a man of 154 pounds body weight can maintain a condition of equilibrium with continuance of health, strength and vigor (to say nothing of possible improvement) with a daily consumption of, say, 60 grams of protein food, and sufficient non-nitrogenous food to yield 2,800 calories, why should he load up his system each day with twice this amount of protein food, with enough fats and carbohydrates to yield 3,500 calories plus?

The result of Chittenden's researches demonstrates that the protein intake must be a little in excess of protein catabolism, as all of the protein is not available and as this is a variable amount, depending on the proportion of animal and vegetable foods to their different degrees of digestibility and availability. Chittenden formulates the following table, showing the amount of food necessary to yield 60 grams of protein:

CHITTENDEN'S TABLE

Variety of Foods	Protein Content	Fuel Value in Calories
1/2 lb. fresh lean beef (loin)	60 grams	308
9 hens' eggs	60 "	720
4/5 lb. sweetbread	60 "	660
3/4 lb. fresh liver	60 "	432
7/8 lb. lean smoked bacon	60 "	1,820
3/4 lb. halibut steak	60 "	423
1/2 lb. salt codfish (boneless)	60 "	245
2 1/8 lbs. oysters, solid	60 "	506
1/2 lb. American pale cheese	60 "	1,027
4 lbs. (2 quarts) of whole milk	60 "	1,300
5/8 lb. uncooked oatmeal	60 "	1,550
1 1/4 lbs. shredded wheat	60 "	2,125
1 lb. uncooked macaroni	60 "	1,665
1 1/8 lbs. white wheat bread	60 "	1,520
1 1/4 lbs. crackers	60 "	2,381
1 2/3 lbs. flaked rice	60 "	2,807
3/5 lb. dried beans	60 "	963
1 7/8 lbs. baked beans	60 "	1,125
1/2 lb. dried peas	60 "	827
1 1/2 lbs. potato chips	60 "	5,728
2/3 lb. almonds	60 "	2,020
3/5 lb. pine-nuts, pignolias	60 "	1,138
1 2/3 lbs. peanuts	60 "	3,584
10 lbs. bananas (edible portion)	60 "	4,600
10 lbs. grapes	60 "	4,500
11 lbs. lettuce	60 "	990
15 lbs. prunes	60 "	5,550
33 lbs. apples	60 "	9,570

Value of Meats as a Source of Nitrogen.—Chittenden, in discussing "the value of meat as food," after declaring that protein food is the supply of nitrogen needed for the body, asks the question, "What advantages do meats possess as a source of this nitrogen?" His answer was: "Meats represent a concentrated form of protein, their nitrogen is readily available, they are easily digestible, they have an agreeable flavor, they add variety to the diet, they contain extractives which have an exhilarating and stimulating effect, they satisfy the pangs of hunger more completely and for a longer period than do the vegetable proteins.

"There can be no question but that meats occupy a somewhat peculiar place in the category of dietetic articles. A close study of the dietetic customs of civilized people indicates that two distinct objects are ever kept clearly in view, viz.: the satisfying of the grosser needs of the body, the needs of general nutrition, and the satisfying of the needs of the higher functions of the central nervous system. Meats plainly share with foods derived from the vegetable kingdom the ability to minister to the former wants of the body, but in addition they have certain stimulating properties which distinguish them from the grosser vegetable foods. They might also in this respect be classed, perhaps, with such articles as tea, coffee, etc., in their power of ministering to the wants of the brain and nervous system. Sir William Roberts has well said that the struggle for existence, or rather for a higher and better existence, among civilized men, is almost exclusively a brain struggle; and that these brain foods, as they have been not inappropriately termed, must be regarded as a very important part of the equipment for that struggle, for if we compare, with our limited information, the general characteristics of the high-fed and the low-fed classes and races, we would no doubt perceive a broad distinction between them. In regard to bodily strength and longevity, the difference is inconsiderable, but in regard to mental qualities, the distinction is most marked. The high-fed classes and races display, on the whole, a richer vitality, more momentum and individuality of character and a greater brain power than their low-fed brethren, and they constitute a soil or breeding ground out of which eminent men arise."

FISHER'S INVESTIGATIONS.—Prof. Irving Fisher, a co-worker of Chittenden's at Yale University, has conducted some interesting experiments emphasizing the effect of diet on endurance(7). In arranging the tests, a large variety of food and dishes commonly prepared in that locality was supplied, and the subjects were particularly enjoined to masticate thoroughly and even to keep liquid foods in the mouth until

well insalivated and to swallow only in response to almost compulsory inclination. The subjects for this experiment were nine in number and the experiment lasted four and a half months. The diet supplied at the beginning contained 28 grams of protein and had a fuel value of 2,830 calories. "The subjects were informed as to the protein content of the various articles of food and were requested to eat those foods poor in protein so long as the appetite evinced no disinclination to them. The exercises carried out as tests of physical endurance were as follows":

1. Rising on the toes as many times as possible.
2. Deep knee bending as many times as possible.
3. Raising the legs from the floor to a vertical position as many times as possible while lying flat upon the back.

The following table will graphically present the mathematical result of these experiments:

FISHER'S TEST DIET AND ENDURANCE

	Calories		Protein		Strength Per cent	Endurance	Weight, Kilos
	Total	Per cent	Gr.	Per cent			
At the beginning..	2,830	100	98	100	100	100	68.2
After 2½ months.	2,670	94	82	80	104	133	67.3
After 4½ months.	2,220	78	51	52	93	189	65.5

Fisher's experimental findings are somewhat opposed to those of Chittenden. Chittenden's experiments evidenced an increase in strength; in the Fisher experiments it was endurance of the men which attracted attention and with proof that endurance was increased, while their strength varied very little either way.

Fisher carried out some comparative endurance tests between sixteen meat eaters (students from Yale University) and thirty-two vegetarians connected with the Battle Creek Sanitarium. The latter had been vegetarians from four to twenty years. They not only abstained from meat, but also from coffee, tea and condiments, and they were also teetotalers and non-smokers. The endurance tests were as follows:

1. Squatting on the heels and rising thence to upright position as many times as possible.
2. Holding out the arms fully extended for as long a time as possible.

The results are shown in the following table:

FISHER'S COMPARATIVE ENDURANCE TESTS

	Meat Eaters	Vegetarians	Percentage of Difference
Knee bendings	383	846	121%
Holding arms out (minutes)	10	49	390%

According to the result tabulated above, the standard of meat eaters is shown as 100, while the endurance of the vegetarians is from 121 to 390, and we may therefore draw the conclusion that strength and endurance have nothing to do with the consumption of generous quantities of protein, as was formerly a matter of faith. Furthermore, it is an admitted fact that great endurance is possible on simple food of low protein value, in support of which we may cite the example of the Japanese and Arabs.

BAELTZ'S INVESTIGATIONS AMONG THE JAPANESE.—Professor Baeltz,[1] a keen observer and one of the best authorities on the Japanese country and people, says[2] that the people of the lower classes in Japan who subsist almost entirely on carbohydrate foods are altogether of more powerful build than those of the upper classes who eat meat. It is well known to students of dietetics that the Japanese for some thousand years past have been experimenting with vegetable and cereal foods, and at the present time the diet upon which the bulk of the Japanese people subsist is sufficient for the maintenance of an effective nitrogen equilibrium, as well as to keep them in a state of efficient nutrition. Professor Baeltz had two jinrikisha men in his employ, both powerful young fellows, aged twenty-two and twenty-five respectively, who had followed their calling for years. They were provided with an accurate amount of measured food, the chemical composition of which was ascertained by recognized men. These men received definite instructions: Every day for three weeks their duty was to drag a jinrikisha with Professor Baeltz, who weighed 176 pounds, a distance of twenty-five miles, running all the time. This would seem to be an arduous task, but not more so than these men would willingly and readily undertake. It would be considered quite an undertaking to walk a distance of twenty-five miles every day for three weeks with an August sun at its best, but for these

[1] Baeltz was, for some years, body-physician to the late Mikado.

[2] Quoted by Dr. Albu in "Die Vegetarische Diät." It should be observed that Dr. Albu writes against vegetarianism, but concedes that one may subsist on vegetarian diet, which is proved among other things by Baeltz's observations.

men to run this distance every day, and to drag a jinrikisha with a passenger weighing 176 pounds, is rather more than one would usually expect.

During this experiment the men kept to their usual diet, which consisted of fats amounting to less than the proposed standard enunciated by Voit(8), while the contained protein fluctuated from between 60 to 80 per cent of his postulate. Carbohydrates were provided in exceedingly large quantities in the form of rice, potatoes, barley, chestnuts, lily roots and other foodstuffs peculiar to the country. The men were weighed. One had gained half a pound and the other was the same as at the beginning. Professor Baeltz now told the men that they would be allowed a liberal allowance of meat, which quite delighted them, as meat to them was a luxury. The carbohydrate ration was cut down and a proportionate quantity of meat—not quite as much protein as the Voit standard, but a considerable amount—was allowed. The men ate with avidity, but after three days on the meat diet they importuned Professor Baeltz to discontinue the meat and to give it to them only upon conclusion of their probation, because they felt fatigued and could not run so well as they did previous to taking meat. Baeltz then allowed them to return to their original carbohydrate dietary, with the same result as before—the one retained his weight, with perhaps a difference of 100 grams, and the other gained about half a pound.

Baeltz records an even greater feat of endurance on a smaller diet. Baeltz was driving from Tokio to Nikko, a distance of about sixty-eight and a half miles. It was midsummer and fearfully hot, and it took Baeltz from six o'clock in the evening until eight o'clock the following morning—fourteen hours—to make the distance. He says that, just as he was driving out of Tokio, he saw a Japanese sitting in a jinrikisha and asked him where he was going. Nikko was likewise his destination and he was being pulled along by a man. He arrived in Nikko just half an hour after Baeltz. Baeltz records that his driver had changed horses six times, and this Japanese jinrikisha man had dragged his compatriot, an adult weighing 119 pounds, a distance of sixty-eight and a half miles at a running pace in about fourteen and a half hours, and on a vegetable diet only.

It is well known that the Japanese are physically a small people, yet they are capable of remarkable feats of strength and endurance, and as recent events have shown, they are full of courage and daring. A writer(9) in the *British Medical Journal* says: "The Japanese themselves attribute their high average of physical strength to a plain and

frugal diet, and to a system of gymnastics, jiu-jitsu, which includes a knowledge of anatomy, and of the internal and external use of water. In 1889 a commission was appointed to consider whether by a meat diet or by other means the stature of the Japanese race could be raised; but the conclusion arrived at was that, seeing that their feats of strength and powers of endurance were superior to races much taller than themselves, the lowness of their stature did not matter. Concerning the diet, they are frugal to a degree, partaking of rice at every meal. Japanese troops have often made record marches on diet consisting solely of a little rice. Vegetables and fruits are grown in abundance in Japan, and their value as a regular part of the dietary is realized with far more advantage than it is in this country. Indeed, a laborer is content to work a whole day on a dinner of tomatoes and cucumbers. Milk is scarce, because it does not pay to raise cows to produce milk alone, and the meat is not eaten."

OTHER FOREIGN NATIONS NON-MEAT EATERS.—According to Sinclair,[1] the Hindu *pattamars*, carriers of dispatches, who eat only rice, run every day, passing from one town to another, twenty leagues at least, and continue thus for weeks. Russian agriculturists, who live on vegetables, black bread, milk and garlic, work sixteen to eighteen hours per day, and their strength is said often to exceed that of the American sailors(10). The Norwegian peasants scarcely know of animal alimentation; they cover, however, whilst accompanying the carriages of tourists, from three to four leagues, running without stopping. Modern Egyptian workmen and boatmen, who from time immemorial have fed almost exclusively on melons, onions, broad beans, lentils, dates and maize, have remarkable muscular strength(11). The miners of South America, very sober workmen, who do not eat meat, carry on their shoulders weights of 200 pounds, with which they mount twelve times a day, on an average, vertical ladders 60 to 80 meters high(12). According to H. Ranke, the woodcutters of Upper Bavaria feed almost exclusively on flour (1,100 to 1,200 grams per day) cooked with hogs' lard (90 grams), without eggs or cheese; on Sundays only they have a little pork. They do, however, an enormous amount of work(13). The Turkish soldier is extraordinarily abstemious; he drinks only water or lemonade, feeds on *pillauf* of rice and figs and scarcely touches meat. We know that his vigor is remarkable and his courage indomitable.

We might learn a great deal from the Arabs with respect to those

[1] We extract the majority of the following facts from the interesting work of Mrs. A. Kingsford (Thèses de Paris, 1880).

diseases which result from excessive meat eating. The French and Italians have long ago experienced the greatest difficulty in their attempts to subdue this brave and energetic people. They are of slender build, but their powers of endurance are remarkable. According to Auzimour(14): "They are slim and wiry people; their limbs are lithe and strong; their profile is more curved than straight. They live in tents which are far from sanitary. The frugality of the Arabs is just as far famed as that of the camel. Men often go on long journeys into the desert with only a bag of meal, some figs, a skin of water and some dates. With the meal the Arab makes his cakes, which, with his dates, are his provision for the day. They are hardy and resist disease." Dr. Auzimour says, "Abdominal wounds, with perforation of the intestines, heal without the use of antiseptics when the injured parts have been replaced. Wounds healing under such circumstances and without consequent blood poisoning are a source of wonder to surgeons acquainted only with Europeans. Diseases of nutrition are almost unknown among them; ulcers and cancer of the stomach are very seldom met with, and if one comes across a case of summer diarrhea, it is generally because the sufferer has been eating too many melons. Appendicitis is very rare among the Arabs, and is entirely unknown among the vegetarian nomads." The experience of Dr. Auzimour is that Arabs who live in towns and who eat as Europeans do are no more resistant to these diseases than the Europeans. We are convinced that common stomach troubles and intestinal disorders quite often arise from fermentation caused by putrefying animal protein, as these complaints disappear like dew under the morning sun on a low protein diet.

Professor Maurel, of Toulouse, who served for thirty years as army surgeon in the French colonies, while in the tropics made experiments in nutrition in consequence of which he has come to the conclusion that most of the so-called tropical diseases are caused through overeating, and particularly through excessive meat eating. In his work on nutrition(15) he arrives at the following conclusions:

1. "That the majority of digestive disorders (dyspepsia, diarrhea, dysentery) which are so common in the tropics are partly to be ascribed to hypernutrition."

2. "That overindulgence in animal foods is largely the cause of the liver disorders met with in the tropics."

3. "That, finally, the increased richness of blood, which is due to the absorption of too large a quantity of food, particularly protein food—

which he has termed hypernutrition—constitutes a contributory cause of the fevers so prevalent in our colonies."

STANDARD FOR PROTEIN REQUIREMENT IN DIETARY

In attempting to formulate the standard for the requisite amount of protein in the dietary, we find no such definite and satisfactory basis for judgment as in the case of the total energy or fuel value of foods. Indications are lacking that any kind of work necessarily increases the expenditure of fuel, or that the body can store up protein to anything like the extent that it stores up fuel in the form of fat; the feeding of protein above what is required for maintenance and body equilibrium increases only slightly the store of protein in the human economy. When one authority suggests an amount of protein but little above the minimum required for equilibrium, and another advocates a much higher amount, there is implied a difference of view regarding protein such as no longer exists with respect to the energy metabolism. The difference, it is true, is hardly so great as might appear from a casual examination of the proposed standards(16). According to the standard of Voit, Playfair and Gautier, protein contributes about 16 per cent of the fuel value of food; Atwater's experience suggests about 15 per cent; while Langworthy puts it at 12 per cent and Chittenden as low as 8½ per cent.

Peschel undertook a personal experiment to determine the amount of protein necessary for his own body; he weighed 169 pounds. He was guided by Rubner's work in nutrition which he considered of especial value, and accepted his data as a working basis: 100 grams of fat, 240 grams of starch, 249 grams of sugar, 770 grams of fresh muscle flesh free from fat, and that the nutrients could be substituted for one another for this purpose. Rubner teaches that "growth is a function of a cell; it can be rendered latent by insufficient protein, but protein cannot raise the rapidity of growth above the level set by nature." Peschel holds that a certain amount of protein is necessary to repair the waste of nitrogenous tissue which is continually going on, as well as to make up for the loss of portions of the epidermis, hair, nails, epithelial cells, etc. His investigations were undertaken at the suggestion and under the direction of von Noorden to determine the exact amount of protein necessary for his body metabolism. He ingested a ration consisting of bread, rice, potatoes, butter, sugar, tea, etc., but no meat. The analysis of his ration showed that he was partaking of 40 grams of protein in a diet which yielded 3,640 calories. On the fifth day he reached his

nitrogenous equilibrium, that is to say, he was ingesting sufficient protein for the needs of the body, and the organism was sufficiently supplied with carbohydrates and fats. He soon reduced the protein to 32 grams per day, the caloric value of his ration then being 3,600 calories, but the organism continued to lose nitrogen on a protein intake of only 32 grams. He therefore concluded that Voit's standard for protein was far above the amount actually needed, provided the organism is well supplied with fats and carbohydrates:

THE NITROGEN REQUIRED FOR MAINTENANCE

Investigator	Body Weight, Kilos	Calories per Kilo	Protein per Kilo, Grams	Nitrogen in Food, Grams	Protein in Food, Grams
Chittenden's physiological minimum.......	70	Varies with work	.50	5.50	34
Voit's Standard........	70	40	1.70	19.10	119
Maurel's Standard.....	70	..	1.50	16.83	105
Peschsel..............	77	46	.50	6.30	40

Students who have carried out experimental researches to determine the amount of nitrogenous food necessary for body metabolism are agreed that individuals can live for some time with no nitrogenous food, and that they can live for a time with no food at all; but such experiments are of no especial physiological value, other than furnishing evidence to determine, from the metabolism of nitrogen, on a nitrogen-free diet or during starvation, the amount of protein needed daily to prevent the disintegration of the body tissues. The observations of Chittenden, Voit, Maurel, Peschel and others, with which Tibbles, who has given this subject much attention, is in complete accord, clearly demonstrate that it is possible to maintain life, keep the body in nitrogen equilibrium and to do a certain amount of work on a diet having the standard caloric value, but containing a very much smaller amount of protein than is usually given in standard dietaries.

Jones closely followed an investigation in the case of Schmehl. This man walked 500 miles in six days, or an average of 83⅓ miles per day, and subsisted on a ration consisting of beefsteak, eggs, beef tea, champagne and aërated waters. Tibbles says, "The severe and strenuous exertion caused an increased excretion of nitrogen, phosphoric acid and sulphuric acid. On the first day of the walk, the urea output amounted to 63 grams, on the last day to 39 grams, so that the excretion gradually diminished during the 500-mile walk. The fact should not be lost sight

of that the diet influences the amount of urea excreted. A man of ordinary stature, in the state of equilibrium and partaking of an ordinary mixed diet, excretes daily from 5 to 40 grams, or an average of 33 grams of urea. When the diet is poor in protein, it may drop to from 15 to 20 grams, but when it is rich in protein, the output may rise to 90 or 100 grams per day."

Atwater and Sherman record an investigation carried out upon Miller, who succeeded in riding 2,007 miles in six days without showing signs of physical or mental fatigue at the end of the journey. Miller was twenty-four years old and the fuel value of his ration was 50 per cent above that of the standard dietaries, showing from 169 to 211 grams of protein daily. Estimates were made of the food consumed. The urine and feces were analyzed and showed that the protein metabolized in his body was more than that contained in his food.

Weston, the American pedestrian, was used for an experiment to determine his nitrogenous equilibrium. He consumed more protein per day than Miller. This investigation was studied by Flint(17) and Pavy(18), who arrived at different conclusions as to the results in this case. Flint avers that severe muscular exertion increases the excretion of nitrogen.

The tables on p. 183, compiled by Flint, show the nitrogen income and outgo before, during and after the walk.

In the study of this subject, the tabulated experiments of Atwater(19) and his associates are enlightening.[1] These experiments were all carried on with the subject in the respiratory calorimeter. The table reports the amount of food ingested, i.e., the sum total of food available for tissue building and for the production of energy. In addition, the table shows the available energy of the food digested, i.e., the difference between the total heat of combustion and the heat of combustion of the unoxidized matter in feces and urine, and also the loss or gain of protein or fat to the body.

Other data shown are the average daily amount of available protein and energy derived from the food, the amount required by the body, the amount required by the body when at rest, and again when engaged in vigorous muscular work.

The dietary standards previously suggested by careful investigators have served their purpose, but they must of necessity undergo various changes as the subject becomes more accurately and scientifically studied.

[1] See Table, page 184.

FLINT'S OBSERVATIONS ON THE EFFECTS OF THE FIVE-DAY PEDESTRIAN FEAT PERFORMED BY WESTON

BEFORE THE WALK

	Weight of Body, Nude, Lbs.	Temperature, Deg. Fahr.	Pulse	Miles Walked	Nitrogen in Ingesta, Grains	Nitrogen in Egesta, Grains	Excess or Deficiency in Nitrogen Egesta, Grains
First Day.....	120.5	99.7	75	15	361.22	323.26	− 37.96
Second Day....	121.25	98.4	73	5	288.35	301.18	+ 12.83
Third Day.....	120	98.0	71	5	272.27	330.36	+ 58.09
Fourth Day....	118.5	99.1	78	15	335.01	300.57	− 34.44
Fifth Day.....	119.2	99.5	93	1	440.43	320.06	−120.37

DURING THE WALK

	Weight of Body, Nude, Lbs.	Temperature, Deg. Fahr.	Pulse	Miles Walked	Nitrogen in Ingesta, Grains	Nitrogen in Egesta, Grains	Excess or Deficiency in Nitrogen Egesta, Grains
First Day.....	116.5	95.3	98	80	151.55	357.10	+205.55
Second Day....	116.25	94.8	93	48	265.92	370.64	+104.72
Third Day.....	115	96.6	109	92	228.61	397.58	+168.97
Fourth Day....	114	96.6	68	57	144.70	348.53	+203.83
Fifth Day.....	115.75	97.9	80	40.5	383.04	332.77	− 50.27

AFTER THE WALK

	Weight of Body, Nude, Lbs.	Temperature, Deg. Fahr.	Pulse	Miles Walked	Nitrogen in Ingesta, Grains	Nitrogen in Egesta, Grains	Excess or Deficiency in Nitrogen Egesta, Grains
First Day.....	118	98.6	76	2	385.65	295.70	− 89.95
Second Day....	120.25	98.4	73	2	499.10	358.81	−140.29
Third Day.....	120.25	99.3	70	2	394.83	409.87	+ 15.04
Fourth Day....	123.5	98.8	78	2	641.71	382.89	−258.82
Fifth Day.....	120.75	97.5	76.5	3	283.35	418.49	+135.14

INFLUENCE OF WORK ON THE FOOD REQUIRED (ATWATER)

Character and Duration of the Experiment	Nitrogen (Grams)	Carbon (Grams)	Energy (Calor.)	Protein (Nx6.25) (Grams)	Fat (Grams)
(a) Rest Experiments					
E. O.: Eleven experiments, average of 37 days:					
In digested food..........	17.7	231.5	2,459	111	...
In material oxidized.......	18.5	218.6	2,297	116	...
Gain (+) or loss (−) to the body.................	−.8	+12.9	....	−5	+20
O. F. T.: One experiment, average of 5 days:					
In digested food..........	14.4	216.5	2,442	90	...
In material oxidized.......	13.7	219.9	2,505	86	...
Gain or loss to the body.	+.7	−3.4	....	+4	−7
A. W. S.: Three experiments, average of 9 days:					
In digested food..........	14.7	214.3	2,344	92	...
In material oxidized.......	13.7	229.1	2,293	86	...
Gain or loss to the body.	+1.0	−14.8	....	+6	−24
J. F. S.: Three experiments, average of 9 days:					
In digested food..........	15.4	228.7	2,381	96	...
In material oxidized.......	15.7	207.8	2,117	98	...
Gain or loss to the body.	−.3	+20.9	....	−2	+29
Total: Eighteen experiments, average of 60 days' rest:					
In digested food..........	16.6	227.3	2,428	104	...
In material oxidized.......	16.9	218.7	2,285	106	...
Gain or loss to the body.	−.3	+8.6	....	−2	+13
(b) Work Experiments					
E. O.: Two experiments, average of 8 days:					
In food digested..........	17.6	326.2	2,462	110	...
In material oxidized.......	17.3	358.9	3,865	108	...
Gain or loss to the body.	+.3	−32.7	....	+2	−43
A. W. S.: One experiment, average of 3 days..........					
In food digested..........	14.8	223.6	2,505	92	...
In material oxidized.......	14.1	371.5	4,225	88	...
Gain or loss to the body.	+.7	−147.9	....	+4	−196

INFLUENCE OF WORK ON THE FOOD REQUIRED (ATWATER)

Continued

Character and Duration of the Experiment	Nitrogen (Grams)	Carbon (Grams)	Energy (Calor.)	Protein (Nx6.25) (Grams)	Fat (Grams)
J. F. S.: Four experiments, average of 12 days:					
In food digested..........	15.0	306.4	3,251	94	...
In material oxidized......	16.0	330.4	3,547	100	...
Gain or loss to the body.	−1.0	−24.0	....	−6	−27
Total: Seven experiments, 23 working days' average:					
In food digested..........	15.9	302.5	3,227	99	...
In material oxidized......	16.2	345.7	3,759	101	...
Gain or loss to the body.	−.3	−43.2	....	−2	−55

HIGH VERSUS LOW PROTEIN DIET

We will now present, from Sherman's(16) summary of the subject, some of the arguments which have been advanced in favor of a high protein and of a low protein diet.

"Liebig believed that fats and carbohydrates were burned in the body primarily to supply it with warmth, and that protein alone served as the source of muscular work and other forms of tissue activity. He therefore classed the non-nitrogenous as "respiratory" and the nitrogenous as "plastic" foodstuffs, and treated the proteins as playing a "nobler" part in nutrition than can be accredited to either fat or carbohydrate. Although it was soon demonstrated that carbohydrates and fats as well as protein serve the body in the production of muscular energy, yet the influence of Liebig's teaching, and of the great attention given to protein in Voit's classical researches on nutrition, together with the fact that protein is the most prominent constituent of protoplasm, has resulted in a strong tendency to associate high protein feeding with increased stamina and muscular power.

The reasoning of those who appreciate the results of the more recent experimental work, and yet believe the general attitude of Liebig and Voit to have been largely sustained by experience, is well expressed by von Noorden, who wrote(20): "The dietary habits of peoples are the results of biological laws, and it would seem that the action of these laws, extending through the thousands of years of existence of the species,

would have resulted in the establishment of suitable habits regarding the amounts of protein consumed. The data gathered by Voit may be taken as showing that this normal habit involves the consumption of about 105 grams of digestible protein per day, a smaller protein consumption being usually associated with weak individuals or inactive peoples. While men can maintain equilibrium on less, still it can rightly be said that a liberal protein consumption makes for a full development of the man. A single individual may for years, or even decades, offend against this biological law unpunished. When, however, the small consumption of protein continues for generations, there results a weak race." Von Noorden, however, is careful to add: "On the other hand, the importance of protein must not be overestimated. A diet is not necessarily good because the amount of protein is right; it must have the proper proportions of the non-nitrogenous nutrients as well, since the protein is not to be depended upon for the necessary fuel value. Better somewhat less protein with a liberal amount of total food, than more protein with insufficient fuel value; the latter brings a rapid loss of strength, the former can be endured very well, at least for a long time, and very likely throughout the life of the individual."

Hutchison(21) advances similar views in regard to the advantage of a liberal protein diet and definitely pointed out that generous protein feeding resulted in more vigorous health and increased resistance.

Chittenden, in 1905(22), arrived at precisely the opposite conclusion: "The products of protein metabolism are a constant menace to the well-being of the body, and any excess of protein over what the body actually needs is likely to be directly injurious, and at best puts an unnecessary and useless strain upon the liver and kidneys." Chittenden has satisfied himself, by his numerous and long-continued experiments, that both physical and mental stamina are promoted by decreasing the amount of protein in the food. Greater freedom from fatigue, greater aptitude for work, greater freedom from minor ailments, have gradually become associated in the writer's mind with this lowered protein metabolism and general condition of physiological economy. "The ordinary professional man who leads an active and even strenuous life, with its burden of care and responsibility, need not clog his system and inhibit his power for work by the ingestion of any such quantities of protein food as the ordinary dietetic standards call for."

Although Hutchison(23) does not refute his early teaching in regard to the views of a high protein diet, he acknowledges the importance of Chittenden's work and states that such a diet cannot be advocated as

being entirely satisfactory. In his more recent work he declares(24) that in a diet yielding 3,000 calories, the normal quantity of protein should be about 75 grams. This is somewhat in excess of the results of Chittenden's experiments, but is in accord with the relation of protein to calories in mothers' milk. This proportion Hutchison considers nature's teaching concerning the normal balance of nitrogenous and non-nitrogenous food for man.

Folin(25) holds that the argument for a high protein diet, based on the fact that large amounts of protein are commonly eaten by those who can afford it, can be equally well applied to the dietetic use of alcoholic beverages and is no more convincing in one case than in the other; while, on the other hand, study of protein metabolism has given rather strong evidence that the body has no need of such amounts as are commonly eaten, for when protein is fed the nitrogen which it contains is usually eliminated more quickly than the carbon, and further study indicates that a considerable part of the nitrogen absorbed from the alimentary tract never reaches the tissues at all, but is converted into urea on its first passage through the liver.

Protein Diet and the Nitrogen Equilibrium.—The loss of body nitrogen which occurs in the early periods of restricted protein feeding, and which was not determined nor specifically discussed by Chittenden, is treated by Folin as follows:

"All the living protoplasm in the animal organism is suspended in a fluid very rich in protein, and on account of the habitual use of more nitrogenous food than the tissues can use as protein, the organism is ordinarily in possession of approximately the maximum amount of reserve protein in solution that it can advantageously retain. When the supply of food protein is stopped, the excess of reserve protein inside the organism is still sufficient to cause a rather large destruction of protein during the first day or two of protein starvation, and after that the protein catabolism is very small, provided sufficient non-nitrogenous food is available. But even then, and for many days thereafter, the protoplasm of the tissues has still an abundant supply of dissolved protein, and the normal activity of such tissues as the muscles is not at all impaired or diminished."

When 30 or 40 grams of nitrogen have been lost by an average-sized man during a week or more of abstinence from nitrogenous food (but with an abundance of carbohydrate and fat), the living muscle tissues are still well supplied with all the protein that they can use. That this is so is indicated, on the one hand, by the unchanged creatinin elimina-

tion, and on the other by the fact that one experiences no feeling of unusual fatigue or of inability to do one's customary work. Because the organism at the end of such an experiment still has an abundance of available protein in the nutritive fluids, it is at once seemingly wasteful with nitrogen when a return is made to nitrogenous food. This is why only gradually, and only under prolonged pressure of an excessive supply of food, protein again acquires its original maximum store of this reserve material.

If the interpretation just given for the phenomenon of nitrogen equilibrium is correct, it constitutes at the same time a definite reason why the so-called standard diets are unnecessarily rich in protein. Nitrogen enough to provide liberally for the endogenous metabolism and for the maintenance of a sufficient supply of the reserve protein is shown to be necessary; but it ought neither to be necessary nor advantageous for the organism to split off and remove large quantities of nitrogen which it can neither use nor store up as reserve material. In the case of carnivorous animals, the uncertainty of the food supply has evidently led to the development of a capacity to store a certain amount of protein in the form of increased muscle substance, but in man this capacity seems not to exist. The slowness with which the normal human organism stores nitrogen after having lost only very moderate amounts does not mean that the human organism can replace lost muscle tissue only slowly and with difficulty. When the organism really has suffered a loss of such tissue, as, for example, during typhoid fever, we know that during convalescence there is an astonishingly rapid recovery of weight and a correspondingly extensive retention of nitrogen.

In the light of the theory developed from Folin's teaching concerning the double nature of protein metabolism and the explanation of the phenomenon of nitrogen equilibrium, the following objection can perhaps be made to the use of large quantities of protein: the excess of nitrogen furnished with the food is normally quickly converted into urea and eliminated, and is therefore normally harmless. The continuous excessive use of protein may lead, however, to an accumulation of a larger amount of reserve protein than the organism can with advantage retain in its fluid media. It is entirely possible that the continuous maintenance of such an unnecessarily large supply of unorganized reserve material may sooner or later weaken one or another or all of the living tissues. At any rate, it seems scarcely conceivable that the human organism, having all the time access to food, can gain in efficiency on account of such an excess of stored protein. The carrying of excessive quantities

of fat is considered as an impediment; the carrying of excessive quantities of unorganized protein may be none the less so because more common and less strikingly apparent(26).

Halliburton(27), in discussing the work of Chittenden and of Folin, concedes that "the prevalence of dyspeptic troubles and uric acid disorders (among the English-speaking peoples) should make us hesitate before we conclude that our diet has reached the stage of perfection, and should rather lead us to admit that the majority of well-to-do people eat too much protein"; but, he adds, "Any change in the practice of years and of generations should be accomplished gradually, not suddenly. It is well known that the liver is the largest organ we possess, and one of its functions is to convert nitrogenous metabolites, which may be harmful, into urea, which is harmless and easily disposed of, and one may gain comfort from the reflection that the organ is adequate in health to deal with large quantities of material. If all of us were immediately to reduce our diet to the Chittenden level, we might be living perilously near the margin; any unusual strain, such as privation or a severe illness, would then find us without any reserve of nutrient energy, and we should probably suffer more severely in consequence."

Benedict(28), after many years' experience in feeding, favors the use of liberal quantities of protein, and says, "While men may for some months reduce the proportion of protein in their diet very markedly and apparently suffer no deleterious consequences, yet, nevertheless, a permanent reduction of the protein beyond that found to be the normal amount for man is not without possible danger. The fact that a subject can so adjust an artificial diet as to obtain nitrogenous equilibrium with an excretion of nitrogen amounting to about two or three grams per day is no logical argument for the permanent reduction of the nitrogen in food for the period of a lifetime. Dietary studies, all over the world, show that in those communities where productive power, enterprise and civilization are at their highest, man has instinctively and independently selected liberal rather than small quantities of protein."

A similar position is taken by Meltzer(29), who compares the appetite for a liberal surplus of protein with the liberal way in which the body is provided with organs and tissues for nearly all of its functions, and concludes that, "valuable as the facts which Chittenden and his co-laborer found may be, they do not make obvious their theory that the minimum supply is the optimum—the ideal." The bodily health and vigor which people with one kidney still enjoy does not make the possession of only one kidney an ideal condition.

"The finding that the accepted standard of protein diet can be reduced to one-half can be compared with the finding that the inspired oxygen can be reduced to one-half without affecting the health and comfort of the individual, but no one deduces from the latter fact that the breathing of air so rarefied would be the ideal. The storing away of protein, like the storing away of glycogen and fat, for use in expected and unexpected exceptional conditions is exactly like the superabundance of tissues in an organ of an animal, or like an extra beam in the support of a building or a bridge—a factor of safety. We therefore believe that with regard to the function of supply of tissues and energy by means of protein food nature meant it should be governed by the same principle of affluence which governs the entire construction of the animal for the safety of its life and the perpetuation of its species."

After considering the arguments of Benedict and of Meltzer, it is noteworthy that in his later book Chittenden(30) says: "It is certainly just as plausible to assume that increase in the consumption of protein food follows in the footsteps of commercial and other forms of prosperity, as to argue that prosperity or mental and physical development are the result of an increased intake of protein food. Protein foods are usually costly and the ability of a community to indulge freely in this form of dietetic luxury depends in large measure upon its commercial prosperity." Moreover, Chittenden contends that his allowance of 60 grams of protein per day for a man of average size is a perfectly trustworthy figure, with a reasonable margin of safety; that dietetic requirements, and standard dietaries, are not to be founded upon the so-called cravings of appetite, but upon reason and intelligence reënforced by definite knowledge of the real necessities of the bodily machinery.

"We must ever be mindful of the fact, so many times expressed, that protein does not undergo complete oxidation in the body to simple gaseous products like the non-nitrogenous food, but that there is left behind a residue not so easily disposed of, and that there are many suggestions of improvement in bodily health, of greater efficiency in working power and of greater freedom from disease, in a system of dietetics which aims to meet the physiological needs of the body without undue waste of energy and unnecessary drain upon the functions of digestion, absorption, excretion and metabolism in general."

Reduction of Protein Dietary Necessary.—The well-to-do families and those living in luxury should especially avoid the excessive and exclusive ingestion of foods from the animal kingdom. There are tables in some families from which vegetables are almost entirely excluded, because it

is said they are not sufficiently nourishing or because they do not make a big enough show, or because they do not satisfy palates accustomed to animal foods; sometimes because their preparation requires more painstaking care and time than the housewife or cook, often from indolence, cares to give them. Again, some individuals seem to think that an excess of nitrogenous alimentation will make up for any deficiency, intentional or otherwise, of vegetable foods. This is a very dangerous error.

On such a dietary children are slow in development, nervous, cacochymic and eczematous. In later life they will be subjects of rheumatism, gout, calculi and nervous disorders. There is no question in our mind but that the degeneracy noted in many well-to-do families is due wholly, or in part, to a dietary composed too exclusively of foods from the animal kingdom. For this reason, which we cannot too strongly emphasize, we ought not to further encourage this tendency by replacing beef and mutton, roast or boiled, by pork, butcher's meat, hash, game, preserved fish, spiced stews, salt or smoked meats, by meat of animals too young and by fermented cheeses with the necessary accompaniment of bitters, stimulants, spices, wines, liqueurs, coffee, tea, etc. Such a dietary, beyond question, augments every sort of disorder of health, leads to race degeneracy and decimates families.

It is beyond question that the dietary habit of well-to-do people, especially Americans, and the dietary standards which have been generally accepted in the past, tend to be decidedly liberal with respect to protein. The custom of physicians and dietitians has been to prescribe protein in quantities which may be believed to be beneficial, but it is known to a certainty that it is not necessary in the amounts usually allowed.

Effect of Increased Nitrogen Diet on Kidneys.—Careful observers have proved that half the standard allowance of protein has amply met the demands of the body for nitrogen, but it has also been shown that anything more than the amount necessary for the formation and repair and wear and tear of muscular tissues is rapidly disintegrated and the urea moiety thrown out of the body; and it is further claimed that the additional amount which is usually consumed is harmful to the organism by throwing extra work upon the kidneys to excrete it. It is also claimed that this extra work thrown on the organs of elimination in turn is the cause of gout, migraine and kindred ailments.

It is a physiological fact that nitrogen may be speedily eliminated, and it has been demonstrated that the amount of nitrogen metabolized is in proportion to the amount consumed. We have already shown that

the amount of urea excreted with an ordinary mixed ration varies from 33 to 37 grams daily; but when an extra amount of protein is ingested the excretion of urea may rise to 50, 60 or even 100 grams per day. On a non-protein diet for several days' duration the excretion of urea may sink to 9 grams. On a diet poor in protein it may drop to 15 or 20 grams.

The function of the kidneys is that of elimination, so that the excretion of urea in moderate quantities is not injurious. It may be granted that if the function of the kidneys is defective, there will be a retention of urea or other nitrogenous waste products in the body and the organism will suffer accordingly. Yet, on the other hand, there are certain sections of the earth where the inhabitants live for months upon flesh, fish and fowl, and they do not appear to suffer more than Americans or Europeans who live on a mixed diet. It is known that carnivorous animals subsist entirely on flesh, and there is no evidence that they suffer from disease of the kidneys, from the overwork of their organs. Moreover, it has been satisfactorily demonstrated that when the amount of protein in their food sinks below the normal level, they soon begin to suffer from digestive disturbances.

Effect of Protein Diet on Strength and Endurance—EFFECT OF LOW PROTEIN DIET ON ANIMALS.—Munk of Berlin(31) made a series of observations to determine the effects of a low protein diet on dogs; he observed that a ration poor in protein caused disturbances of the organism, seriously interfering with assimilation; the absorption of fat was the most disturbed, that of protein next, and that of carbohydrates the least molested of all. The animals did not recover their nitrogenous and nutritional equilibrium until their protein ration was increased. When they were allowed skim milk, beans or other nitrogenous food, a distinct improvement in their condition was noticeable. It is well known to the farmer that bacon from pigs fattened on a low protein diet is poor in quality. It is also well known that the milk of cows fed on a ration deficient in protein is poor in fat; the cows become thin, their coats harsh, and they present an ill-fed and ill-kept appearance.

Observations of the effects of the different food elements on man are confirmed by these experiments upon lower animals. Although it is known that individuals can live and continue to keep up both health and work for months on a diet poor in protein, nevertheless this course cannot be continued for an indefinite period. After a time vitality is lowered, resistance to disease is weakened, the activity of the body is lessened and the powers of endurance are stunted. Both careful obser-

vation and experience point to the disadvantages of a low protein diet.

The expenditure of energy is required by muscular work, and to this end more fuel must be consumed. It has been demonstrated that for the production of energy, protein, fat and carbohydrate can be interchanged in a definite proportion. It has also been demonstrated that the increased excretion of nitrogen during and after muscular work is not in proportion to the amount of work. On the contrary, the energy expended in doing work is derived in great part from non-nitrogenous foods.

It is evident, therefore, to the careful student of dietetics that when extra work is to be performed a more liberal allowance of fat and carbohydrate must be added to the ration. But this point is not settled beyond dispute, since it has been the custom for ages past to increase the total food protein in proportion to the extra work to be done. However, from the viewpoint of endurance it is generally accepted as a fact that men who partake liberally of animal foods are more powerful and have greater staying qualities than those who consume little meat(32). The carnivora are more powerful and energetic than the herbivora. The lion or tiger is more vicious than the deer or elk. "Horses fed on beans or oats have more spirit and endurance than those fed on hay or grass." It is an indisputable fact, nevertheless, that feats of endurance can be performed on a purely vegetarian diet; but this may not necessarily be deficient in protein, so, after all, it makes no difference whether the protein is taken from the animal or vegetable kingdom.

The difference between an animal fed on a highly nitrogenous diet and one supplied with little nitrogen is the difference between a steam engine at half pressure and one which is producing its full horse power. It is the difference between a tiger pacing its cage and a cow lying upon the grass; both are healthy, but the type or degree of health is very different in the two animals. "A hunted deer," says Haughton, "will outrun a leopard in a fair and open chase, because the work supplied to its muscles by the vegetable food is capable of being given out continuously for a long period of time, but in a sudden rush at a near distance, the leopard will, without doubt, overtake the deer, because its flesh food stores up in the body a reserve or force capable of being given out instantaneously in the form of exceedingly rapid muscular action."

PROTEIN DIET AND OCCUPATION.—Before concluding this subject, we desire to call attention to the disadvantages of a purely vegetable diet, which affects the outdoor laborer much less than the one engaged in sedentary vocations. The laborer or lumberjack actually requires a

large amount of carbohydrate food to enable him to perform his muscular work, and in partaking of large quantities of vegetable foods for this purpose he is pretty sure to get as much protein as his body requires. The free action of the skin, too, from his strenuous exertions carries off from the body the excess of water which his diet contains, while his active work in the open air induces an appetite for large meals. With the sedentary worker the case is different. He requires much less carbohydrate food than the laborer taking strenuous exercise in the open air, while his body demands considerable protein. In endeavoring to obtain from purely vegetable sources a sufficiency of nitrogenous food, he would inevitably overburden his diet with an excess of non-nitrogenous foods, which his comparatively feeble digestion would be unable to metabolize, while his skin would not act, as in the case of the laborer, to rid the body of the surplus water which such a diet would contain. For these reasons, a man of sedentary occupations is much less likely to be a successful example of vegetarianism than one who leads an active life.

THE AMINO-ACIDS IN ANIMAL AND VEGETABLE PROTEINS.—In studying the physiology of absorption (Volume I, Chapter VI) we learned that all proteins, whether from the vegetable or animal kingdom, consist of amino-acids(33). The amino-acids of animal proteins are identical with those of vegetable proteins, and therefore it would appear *à priori* that there can be little difference in their value upon the organism. It is a remarkable fact that the most valuable vegetable proteins are deficient in flavoring agents, while these bodies in meat, fowl and fish add to their palatability.

Minimum Protein Requirement to Maintain Nitrogen Equilibrium.—The evidence advanced by some observers that the amount of protein prescribed in standard diet is injurious to the organism is not conclusive, but there is ample evidence of the bad effects of a long-continued diet of low protein value. Cohnheim holds that Chittenden's experiments do not prove that men eat too much protein, believing that they can live for a time upon a smaller amount of protein than usual. He believes that most men cannot continue to live upon an allowance of from 50 to 60 grams of protein and keep in good health. With Caspari and Loewi he holds that a healthy, full-grown man requires at least 80 grams of protein daily, and this is a considerable reduction from the standard diet. We can safely take Chittenden's experiments as the *protein minimum* of the so-called standard dietaries which show that the customary or average protein consumption of the most successful nations represents the necessary amount or *optimum* protein consumption, but Folin holds

to the view that the *protein optimum* lies somewhere between these two points.

The minimum ration of protein to secure nitrogenous equilibrium was fixed by Voit at 118 grams in twenty-four hours, while Miller asserts that the minimum nitrogenous ration has been fixed too high, and that 60 grams of protein should be considered the minimum. This coincides with the teaching of Chittenden, who agrees that 60 grams of protein are insufficient; and again Rubner believes the daily necessary potential would be maintained by 35 grams of protein for an adult in whom growth was complete. Klemperer was able to maintain nitrogenous equilibrium on 33 grams of protein by giving at the same time a liberal allowance of fats and carbohydrates.

Siven, in his interesting work(34), and Peschel, in his inaugural address(35), prove that nitrogenous equilibrium may be secured with an alimentation containing only 40 grams of protein, and that, under these conditions, the organism does not draw in the slightest manner upon its own protein, provided the quantity of calories lacking is made up by a liberal allowance of fats and carbohydrates.

Hutchison(36), although acknowledging that Chittenden's results show what men can exist upon, holds that their general application would be attended with risk. In solving the problem of protein requirements, Hutchison makes an interesting comparison between the diet of an adult and that of a nursing infant. The daily supply of milk taken by an infant six months of age contains about 14 grams of protein, furnishing 578 calories; the average energy value of the food of an adult, on the other hand, equals 3,000 calories, i.e., the standard of protein, in the same proportion, would be about 75 grams, the infant's growth being offset by the daily expenditure of energy in the routine life of an adult. Halliburton's results coincide with the results of Chittenden's experiments with metabolism and he points out the danger of living too near the protein minimum.

Safety Standard in Diet.—It may be definitely concluded that the body must have the minimum of protein, an increased proportion being of value because of its action as a stimulant to metabolism and as an accessible source of energy; that the ingestion of protein in larger amounts than Chittenden's standard is advisable, since it increases resistance to disease, probably due to the manufacture of antibodies resulting from the stimulation of the body to this end. The fact that those who are forced by their lack of means to live on a low protein diet are more susceptible to disease has long been accepted. A definite quantity to be

known as the protein optimum cannot be fixed, for it is doubtless influenced in the case of every individual by the personal equation. The pivot on which the protein problem rests is the question of the desirability of storing proteins and of maintaining them on a high level or on a low level. For certain individuals a high level is better, for others a low level, on the condition that the alimentary organs are able to digest and assimilate proteins, and the kidneys are able to transform the nitrogenous waste into urea for ultimate excretion. The young thrive on protein food; during the period of middle age, however, the metabolic processes are less active, and then protein ingested in amounts greater than the physiological requirements tends to a condition of obesity, and the urea is not eliminated with as much facility because of decreased hepatic efficiency and lessened activity of the renal excretory power. With these conditions present, the amount of protein in the dietary must be held down, so that the optimum at this epoch falls below that of youth and early adult life.

CAUTION AS TO PROTEIN DEFICIENCY.—Before leaving this subject we desire to urge a word of caution against a deficiency of food in the diet—protein, being the most costly, is the principle most likely to be short in the diet. Of late, considerable discussion—as emphasized by experiences recorded in this chapter—has arisen as to the exact amount of protein required daily by the adult after the period of growth is complete. For generations past it has been considered that protein starvation is the cause of much ill health and misery. In our own country, among the poorer classes in the South, particularly in the mountain districts and among the poorer children working in factories, it is not uncommon for individuals to live upon a diet in which "tea, bread and butter" figure prominently, with an occasional bloater or other appetizer. While such a diet may yield sufficient heat to supply the demands of the body according to scientific requirements, it does not give the consumer strength and endurance. The general principles laid down in this chapter should guide us in directing a diet for people of this type, and especially where the cost of meat, fish, fowl, eggs or milk is prohibitive, to suggest and direct the freer use of beans, peas, lentils and nuts which would supply the necessary protein to make up a well-balanced ration without an excessive expenditure of money.

UNDEREATING.—Undereating is often coupled with indigestion in such a way that it is impossible to say which is the cause and which the effect. Within wide limits the digestive glands accommodate themselves to the tax levied upon them, providing adequate amounts of their

juices for large or small meals. Low diet, therefore, may weaken the adaptability of the organs it is designed to spare (Howell).

Benedict, of the Carnegie Nutrition Laboratory, has severely criticized those writers who go to extreme lengths in their championship of reduced feeding. He has shown that when the food supply is very small the absorption is often less complete than with a more liberal diet, indicating that the digestive system is not in such good working order as it might be with more to do. Chittenden, the foremost advocate of careful restriction, agrees with his critic to this extent at least—that he believes that an occasional big dinner is a valuable means of testing the canal to see whether it has retained the reserve power which it should have. We must admit, in spite of the scientific investigations laid down for the bodily requirements of persons in adult life, that these standards are subject to a personal equation which will upset the calculation, and therefore the scientific figures can only be considered as general averages.

OVERFEEDING.—Overfeeding, especially in youth and early adult life, may be disposed of by quick digestion and speedy assimilation, great metabolic activity and greater physical exercise, whereby the excess of food consumed is rapidly used up and eliminated; but when the middle mile post in life's journey is reached, the body is less active and the same interest is not taken in cricket, football, golf and other outdoor games as in early life. Consequently, less food is metabolized and the "undesirable balance" remains as a "sin against Nature." It is quite true that a certain portion of this surplus may be stored up in the body as protein, glycogen and fat and may thereby lead to obesity. On the other hand, there are persons who "love to eat large meals," who lead an inactive life, follow sedentary occupations and live in warm rooms "lapped in luxury," who never put on flesh. Luxurious habits, especially overindulgence in meat, give rise to various stomach, kidney and arthritical complaints. Even though it may be taken into account that gourmands are the most frequent sufferers from the above disorders, this does not settle the matter, for he who "eats well" often "drinks well," and which of the two is the culprit, the protein or the alcohol? In the majority of instances it might be safe to assume that these boon companions share the responsibility between them. But this "undesirable balance" is the causative factor in a variety of ills, such as bilious attacks, migraine, headache, lethargy, diseases of the liver, kidneys, blood vessels, and favors the production of rheumatism and gravel and kindred affections, not to mention the various auto-intoxications and

putrefactive stasis of the alimentary canal. The decomposition of the end-products of protein digestion takes place in the colon; hence, in this region, products of decomposition develop, such as indol, phenol, skatol, volatile fatty acids, aromatic acid, ammonia, carbonic acid, methane, sulphuretted hydrogen and methyl mercaptan.

The Greek and Spartan athletes of old were wholly or mainly abstainers from flesh foods, and won in all strenuous combats, until they began to eat flesh to make themselves "fierce," after which they began to lose in their conquests in the stadium. The diet of the country laboring classes, for half a century past, was almost wholly innocent of flesh meats and strong drinks, and it must be borne in mind that it is to this sober and temperate ancestry that the working powers of this present generation are owed. The use of flesh in the daily ration of food dates from hardly more than one quarter of a century among the peasantry of the most rural districts, and already they are beginning to degenerate.

ILL-EFFECTS OF ABSORPTION OF END-PRODUCTS OF PROTEIN DIGESTION.—Does muscular strength decline on a rich protein (meat) diet? Physicians are well aware of the weakening effect of a meat diet such as, in the past, has been prescribed for diabetics. If the lower protein estimate of Chittenden and others, say of 60 grams, be sufficient, is it not a question, then, of serious moment to tax severely the organs of digestion and assimilation with from 120 to 200 grams of protein? The end-products of protein digestion which cannot be entirely consumed in the body leave behind a large proportion of incombustible waste material which the liver and kidneys are called upon to excrete, putting extra exertion on these organs. If this large amount of protein is unnecessary, it is not a very far step to the assumption that it must be injurious, because a considerable amount of energy must be devoted to catabolism in the cells and to the excretion of its waste products by the kidney, energy which might otherwise be utilized and assist in metabolism of the muscles.

PROTEIN STRUCTURE AND PROPERTIES

Chemical Formation of Protein Fractions.—It is an established fact that proteins are the actual *vehicles of life* and upon their properties the very possibilities of life depend. The huge molecules of the proteins have been teased and torn out—to borrow a term of histology—and as a result the conception of an unwieldy group of atoms has been replaced

by that of an orderly structure composed of comparatively simple building stones, forming a neatly constructed block of masonry rather than an amorphous mass of concrete. These building stones are now familiarly known as *protein fractions.* Some of them have long been known as rare ingredients of the excreta—such, for instance, as tyrosin, leucin and cystin—but whence they came and how they were formed in the body has been until recently unknown. Widely as the protein fractions differed in their structure, they have this in common: they are *amino-* or *di-amino-acids,* and share the properties of acids and bases. They are, furthermore, capable of combining with each other to form complicated chains or networks which constitute the protein molecules, and since they admit of combination into many different groupings there is a possibility of almost infinite varieties of protein structure.

QUANTITATIVE DIFFERENCES OF PROTEINS.—A great deal of our newer information concerning the proteins we owe to Osborne and Mendel(37). They have experimented with pure proteins and they have shown definitely that certain amino-acids are indispensable in food. With certain proteins—lacking certain of the amino-acids—maintenance, but not growth, occurs. With other proteins deficient in certain other amino-acids, not even equilibrium can be maintained. For instance, they have shown that the protein of *corn* (zein) is an inefficient protein, and that when zein serves as the sole source of nitrogen in the diet, nutritive failure results. It is a perfectly digestible protein, but lacks tryptophan and lysin. Likewise, *gelatin* does not contain tryptophan, an amino-acid, which is essential for the maintenance of the body nutrition. The addition of both of these latter to zein completes it. Add tryptophan alone, and equilibrium is maintained. Add both, and growth follows. Glutelin of corn is a complete protein, but it does not occur in *sufficient* quantity to balance the *deficient zein,* therefore corn is not a complete protein. Other proteins which are relatively poor, though not entirely lacking in certain amino-acids necessary for growth, are gliadin of *wheat* and hordein of *barley.* To this class also belong the protein of *hemp seed,* edestin, which is comparatively poor in lysin. Wheat gliadin will serve to maintain equilibrium, but will not permit of growth. Add lysin to gliadin, however, and growth results. Gliadin is evidently a better source of nitrogen than zein. Lysin is present in many foods; for instance, 9.6 per cent in lactalbumin, 7.59 per cent in ox muscle, 4.81 per cent in the yolk of eggs, 4.98 per cent in peas, 4.58 per cent in beans, 7.61 per cent in casein. The addition of any of these to a corn or wheat dietary adds to its efficiency and tends to insure

growth. These facts apply to adult animals, but, to be sure, they also apply more trenchantly to young animals.

The energy value of *gelatin* is inferior to protein for growth and repair. It is, however, a true protein, though not complete, and, therefore, gelatin alone cannot maintain protein equilibrium in nutrition. The "incompleteness" of food value is doubtless due to the absence of certain amino-acid radicals, conspicuously tryptophan, in the gelatin molecule. Gelatin alone would not supply the necessary protein content of a well-regulated dietary. If one were to rely largely on gelatin as a food it would be necessary to add other proteins, such as those of milk, rich in particular amino-acids which gelatin lacks.

QUALITATIVE VARIATIONS IN THE AMINO-ACIDS OF PROTEINS.—In the table, Volume I, Chapter III, are clearly shown the variations to be found in several of the typical proteins. The most marked differences in amino-acids from a quantitative point of view are very definite. Again, considered from the qualitative standpoint, variations in nutritive value are very important. The mention of a few of the most striking variations may serve to make this point more clear. Albumin and casein contain no glycocoll; gliadin derived from wheat is also glycocoll-free and contains only a negligible trace of lysin; zein derived from corn contains neither lysin nor tryptophan; and gelatin has no tryptophan, tyrosin or cystin. Munk and Voit, in their well-known work, were the first to emphasize the bearing of the qualitative variations in protein from the viewpoint of nutritive value, especially as regards gelatin, which they proved could not sustain nitrogen equilibrium. Escher showed that the addition of tyrosin to gelatin increased its value to the point of establishing nitrogenous equilibrium. This work constitutes the introduction to a series of experiments which have done much to solve many puzzling problems associated with the metabolism of nutrition. It is not the purpose of this work to enter into the details of all these experiments, but a glance will be given to the more important.

Kaufman demonstrated that gelatin with the addition of the missing amino-acids, tyrosin and tryptophan, is capable of maintaining nitrogen equilibrium for short periods in man and dogs. Willcock and Hopkins(38) report most interesting experiments with zein, which, as has been said, is deficient in lysin and tryptophan. Light from new angles is thrown on the problem under consideration and the results accord perfectly with the most recent theories. According to these investigators:

We are no longer bound to Liebig's view, or to any modification of it which implies that the whole of the protein consumed is utilized as intact protein; nor

are we even compelled to assume that the whole of what is broken down in the gut is resynthesized before utilization. Protein products may function in other ways than in the repair of tissues or in supplying energy. It is highly probable that the organism uses them, in part, for more specific and more immediate needs. The discovery of substances absolutely essential to life, highly specific, and elaborated in special organs, suggests that some part, at least, of the protein products set free in the gut may be used directly by these organs as precursors of such specific substances. In adrenalin, for instance, we have an aromatic substance absolutely essential for the maintenance of life, and it is probable that the suprarenal gland requires a constant supply of some one of the aromatic groups of the protein molecule to serve as an indispensable basis for the elaboration of adrenalin. If this be so, it is certain that the gland itself could not, in starving animals, supply sufficient of such a precursor to outlast the observed survival periods. Since adrenalin must be produced at all costs, the required precursor must, in starvation, be obtained by tissue breakdown outside the gland. We may be sure, however, that adrenalin is far from being the only substance elaborated to which such considerations apply. Similarly, in an animal upon a diet sufficient to supply energy, but lacking in some essential group, the minimal waste in the general tissues of the body will be determined by the special need of the organs for the missing group. On this basis we have a hypothesis to account for the special protein-sparing properties of gelatin. It shares with protein certain molecular groupings needed to satisfy specific needs, and is thus superior to fats and carbohydrates as a protein sparer; it lacks, on the other hand, certain necessary groupings, fails therefore to supply all such needs, and thus cannot replace protein.

Physical Properties of Proteins.—In the process of metabolism, the rôle of the proteins is fast becoming the rôle of the amino-acids. The body metabolism makes use of amino-acids, but the human economy must be fed proteins from which the amino-acids are derived, and they depend in amount not only upon the chemical composition of the protein, but upon its physical character and also upon other substances combined or mixed with the alimentation. It has long been thought that the proportion of ingested protein that is digested and absorbed from bread varies according to the amount of the outer cortex (bran) of the grain present in the flour, less being absorbed from bread made from the coarser meals and flours; that the percentage of cellulose in other foods also has a bearing on the absorption of protein.

It has been shown by Hart and McCollum(39) that the inadequacy of corn as an exclusive food is due partly to the character of its proteins, partly to the deficient mineral content. When these deficiencies are supplied, normal growth is possible on a dietary composed largely of corn.

In order to understand clearly the rôle of proteins in growth from the standpoint of the sources of our food, it is necessary to appreciate, first, that the utilization of proteins depends on the characteristics of

the proteins themselves or of the foods containing them, which make them resistant, and not to the digestive enzymes and hormones, which influence the rate of their passage through the alimentary canal; second, their digestion and assimilation: to what extent they can supply the essential amino-acids in the proportion in which the body requires them for the wear and tear and tissue building; and third, the physiological effect of individual amino-acids, especially, perhaps, those furnished by the proteins in question in excess of the body needs(40).

RELATIVE ABSORPTION OF PROTEINS.—The experiments of Mendel and Fine(41), recently confirmed by the findings of Howe and Hawk(42), show that when fed in a more or less isolated form, the proteins of cereals are as completely digested and absorbed as the proteins of animal food—91-97 per cent; but for the proteins fed in the natural food these values do not hold. Only 80-85 per cent of the nitrogen of wheat bread is absorbed, 70 per cent of rye, 58 per cent of pumpernickel, 40.76 per cent barley and 61-82 per cent of corn nitrogen. These percentage values, showing the amount of protein absorbed from whole grain cereals, were determined by methods less accurate than those now in use, but they serve to show the comparable absorption of proteins from different cereals, and show undoubtedly lower protein utilization in grains than in isolated grain proteins.

DIFFERENCES IN SUITABILITY FOR TISSUE CONSTRUCTION.—"With equal digestion and absorption, proteins may still differ greatly in their suitability for tissue construction and otherwise in their physiological effect." According to Howe and Hawk:

> The proteins of meat and of the commercial wheat preparation, gliadin, are about equally well digested and absorbed, but when fed for a period of five days in equal quantity and in similar rations, gliadin gave a negative nitrogen balance of 1.3 grams, while meat gave a positive balance of 11.3 grams.

Osborne and Mendel have shown that a large number of proteins contain all the amino-acids necessary for growth: ovo-albumin, ovovitellin glutenin, maize glutelin, edestin, casein, lactalbumin. Hart and McCollum(43) and their co-workers have found several natural mixtures of proteins occurring in wheat, corn, oats and milk which furnish the amino-acids requisite for tissue construction. McCollum, in comparing the protein mixtures of the grains previously enumerated, with one another and with the protein mixture of milk to determine their availability for growth, found the available nitrogen of cereals to be 23–24 per cent; 45 per cent casein nitrogen and 63 per cent of milk nitrogen

fed as milk. It is evident, therefore, that the amino-acids resulting from the digestion and assimilation of milk proteins not only contain all the units necessary for tissue building, but contain them more nearly in the proportion in which they can be used than is the case with the other foods considered. Wheeler says:

> If there is a shortage of one amino-acid essential to the building of body protein, the amount of that acid present determines not only the amount of tissue construction, the rate of growth, but determines also the proportion of the food protein that can be used for growth. It has been found that the body metabolism can store very little reserve amino-acid—practically all of the amino-acid that cannot be built into protein is promptly deaminized and the nitrogen excreted.

The investigations of Osborne and Mendel(44) have thrown light on the nutritive value of individual amino-acids: the aromatic amino-acids are essential to maintenance; cystin, lysin, probably arginin, and histidin are essential for growth. Again Wheeler says:

> An understanding of the rôle exerted by the individual amino-acids in metabolism suggests wonderful possibilities, for in the future it will be possible for the physician or dietitian to feed a frail, undersized child on just the right combination of milk, eggs and cereals to furnish the amino-acids he needs, in the right proportion, with no large excess of any one to overtax the excretory system or to overstimulate metabolism; a worn-out neurasthenic can be given just the right amino-acids to replace worn-out tissue and enough glycocoll to stimulate metabolism.

Enough has been drawn from the writings of Osborne, Mendel, Howe, Hawk and others to make us feel the importance of knowing the protein composition of foods and how to mix them in order to obtain a sufficient quantity of complete protein. It is evident to the careful student of dietetics that there is but one general way in which to formulate the diet question, bearing in mind the fact that "a man who maintains his weight may be in excellent nutritive condition, but a child who does the same thing may be failing to grow"(45).

THEORIES OF PROTEIN METABOLISM

After weighing all the discussions *pro* and *con* as to the necessity for protein in the dietary, we come to the conclusion that a reasonable surplus of protein from suitable food materials can hardly be injurious, and may be advantageous. Whether such a surplus should be especially recommended or not is largely a question of economics. Where little money can be spent for food there is danger that too little food may be eaten, and it should be remembered in suggesting dietaries that protein

can be secured from beans, peas, etc., at about two-fifths the cost of obtaining it from porterhouse and sirloin cuts of steak. In considering this subject, we must not be misled by the popular statement that "protein builds tissue" into supposing that a liberal amount of protein can keep the body strong in spite of a deficiency in the total food. This impression is somewhat general, but is certainly incorrect.

From investigations of Chittenden, Fisher, Peschel, Hindhede and others, coupled with our own personal experience, we find that physical strength and bodily health can be maintained on a low protein diet, but it is difficult for students following the teaching of the scientists of the old school to rid themselves of the idea that there must be "something" of especial value in meat. It would seem to be rather difficult to express the exact truth of what this "something" is. We know that this "something" has nothing to do with health, with working ability, with strength and endurance; it is energy.

According to Hutchison(46), it is undoubtedly possible to maintain a healthy life upon the protein contained in a moderate quantity of vegetable food, and the accumulated experience of vegetarian races fully bears this out:

> This, however, does not dispose of the question. There is such a thing as degrees of health. While one freely admits that health and a large measure of muscular strength may be maintained upon a minimum daily supply of protein, yet I think that a dispassionate survey of mankind will show that races which adopt such a diet are lacking in what, for want of a better word, one can only describe as energy. Now, energy is not to be confused with muscular strength. A grass-fed cart horse is strong; a corn-fed hunter is energetic. Energy is a property of the nervous system; strength, of the muscles. Muscles give us the power to do work; the nervous system gives us the initiative to start it. Muscles do their work upon carbohydrates, which are the characteristic nutritive constituent of vegetable foods; the brain appears to require nitrogen, which can only be obtained in a concentrated form from animal sources. If protein food, therefore, be regarded as a nervous food, a diet rich in it will make for intellectual capacity and bodily energy, and it is not without reason that the more energetic races of the world have been meat eaters.

It should be stated that Hutchison's theorizing concerning protein *versus* nervous energy and brain work is, at present, simply his personal opinion, not formed on exact observations. Mental work exercises no direct influence on metabolism. The molecular changes which are characteristic and lie at the foundation of all mental processes are neither oxidation nor decomposition processes, or, if they are, they are too slight in degree to be calculated by our present methods.

In order to maintain the blood and muscles in a good physical condition, an abundant supply of protein seems to be necessary, and by promoting oxidation, it increases vigor and diminishes the tendency to an undue accumulation of fat. The nervous system also requires a plentiful supply of protein, if those mysterious influences which emanate from the brain and spinal marrow are to be maintained with sufficient potency to enable the tissues to ward off the inroads of disease. It is claimed that persons who habitually live on a protein minimum convalesce very slowly after an acute illness, for the reason that, when their tissues are broken down, they have no ready surplus of building material out of which to repair them. An increase in protein intake produces a rise in protein metabolism. This occurs to such an extent that the organism is generally able to maintain itself in nitrogenous equilibrium on the most diverse amounts of protein. This coincides with the observation of von Noorden and others, that the body is unable to store any excessive amount of protein.

These two observations are only two different ways of stating the same fact. At first sight, the fact that the organism is able to break down as much protein as is conveyed to it, appears not to agree with the law that the degree of protein metabolism varies with tissue requirements and not with the amount which is presented to the cells. The law is absolutely true so far as the consumption of oxygen- and nitrogen-free substances is concerned. The extraordinary variations in protein consumption, which may, with a rise in the intake, reach to ten or fifteen times the normal, have occasioned much uncertainty, so long as the degree of the metabolism is regarded purely from the standpoint of protein metabolism.

We all know the feeling of well-being which follows a meal containing meat. Physiologists tell us that this condition of well-being is due to the protein in the meat and not to its extractives, as it has been demonstrated that the addition of extractives of meat to foods, such as bread, will not produce this feeling of contentment and well-being. On the other hand, oatmeal, which is rich in protein, is capable of bringing about, to a certain extent, this degree of well-being. A full meal of nitrogenous food is an actual stimulant to the tissues of the body.

It has to be remarked concerning animal food that, while in the raw state, it may be readily digestible with little or no previous mastication, since massive pieces of it are readily attacked by the digestive juices, this is much less true of animal food the proteins of which have been coagulated and rendered less permeable by cooking. Yet the most indigestible form of egg white is the raw liquid albumen; it resists digestion

so much that even a dog can utilize only 50 per cent of the nitrogen, the balance being excreted in the feces. Large lumps of hard-boiled egg or overdone meat may obstinately resist gastric digestion—indeed, the relative digestibility of animal foods depends more upon physical consistence than chemical composition; beef is generally more indigestible than mutton, and pork or veal than either, not so much by virtue of chemical composition as of physical consistence.

Americans are said to be the greatest meat eaters in the world. The average American feels that he must have meat at least twice a day, and not a few of them are dissatisfied if they do not have some form of meat at every meal. That this excessive meat consumption is injurious to a great many people, and especially to those living sedentary lives, is attested by the clinicians who are called upon to treat disturbances in nutrition and metabolism. That a heavy meat diet is not necessary is amply demonstrated by the experience of the Japanese soldiers in the war between Russia and Japan(47), and is being demonstrated at the present time in the European war, where the soldiers have been forced to accept a diet that is almost wholly vegetarian. The testimony of those who are familiar with conditions seems to indicate that the soldiers are much better off on the vegetable diet than they were when they obtained a liberal supply of animal food. May we not learn a lesson from the experiences of the European soldiers which were brought about by force of necessity?

We believe it good advice to direct a liberal allowance of meat up to middle life, or, to be more exact, to the thirtieth year, when it is no longer necessary to have an alimentation for building more tissues or to promote growth, but only to maintain an equilibrium of weight and strength. From thirty to the thirty-fifth year a man should begin to restrict his meats; after thirty-five he should partake of meats less freely, more especially the red meats; after forty-five he should eat meats sparingly; after fifty he should only eat very small portions of meat once a day. We are satisfied that the American people would be better off by far if they had 50 per cent of the protein eliminated from the daily alimentation.

Man at maturity—the thirtieth year—from habits formed in early life, habitually eats too much. The wholesome appetite of healthy childhood is strongly established and the pleasure of eating has become a habit as fixed and inviolable as the "laws of the Medes and Persians." Therefore, most men and women are inclined to eat too much and too rich food that, although palatable, is indigestible. It is at this time that indiscretions of diet are most frequently the cause of disorders of digestion and assimilation. It is without question that we would be

satisfied with less aliment and more particularly much less protein than we have been accustomed to ingest.

At this time of life the habit of only eating what is needed should be acquired and the earlier habits of life should be broken. The average man should limit himself to small portions and should make it a rule not to have the second helping of any kind of food at a meal. This general rule is, of course, subject to modification, for individuals engaged in strenuous occupations require a somewhat more liberal dietary allowance containing the ternary food elements. General practitioners in agricultural districts frequently observe that farmers, during the summer, when their occupation is most strenuous, eat very heartily. Their work in the open enables them to consume and digest large amounts of food. Unfortunately, during the winter months, when their work is comparatively light, they continue the same habit and spend too much time at the table and consume an inordinate amount of food as compared with their activities. Such indiscretions at first cause slight gastric disturbances, but later on chronic digestive disorders will result.

We have a suspicion that a vast number of ailments and disorders of the stomach, nerves, liver and kidneys, not to mention gout, are to be attributed simply to the overfeeding on meats. In the past, when these dyspeptic and nerve-weary patients presented themselves, complaining of drowsiness, debility, general disgust with life, etc.—all due to the ingestion of too much protein—how often has the physician exhorted them to eat plentifully! Worse advice could not have been given. Chittenden, formerly a believer in a high protein diet, and particularly in meat, has lately seen the error of the older views, and now believes in and teaches a low protein diet. Accordingly, body weight, health, strength, mental and physical vigor and endurance can be maintained with at least one-half of the protein food ordinarily consumed; a kind of physical economy which, if once entered into intelligently, entails no hardships, but brings with it an actual betterment of the physical strength, increased endurance, greater freedom from fatigue, and a condition of well-being that is full of suggestion for the betterment of health.

Whether the fatigue poisons come from the excessive exogenous catabolism of proteins in general, or whether they are derived directly in a measure from flesh foods, need not be considered here; the main point is that by lowering the rate of protein catabolism, which necessarily compels a reduction in the amount of flesh foods, there is a diminished quantity of nitrogen waste floating about in the body. Fur-

ther, we need not criticize too closely the method by which the reduction of food is accomplished: whether it be by encouraging prolonged mastication, with a view to better tasting and fuller enjoyment of the food, to the point of involuntary swallowing; or whether it be by advising our patients to follow natural impulses, mastication, taste and appetite reënforced by the use of reason with a full appreciation of the principle that the welfare of the body is best subserved by a quantity of food commensurate with true physiological needs.

According to writers on dietetics, one principle in sitology which has not received adequate recognition may be summed up as follows: "The dietary standard varies not only with the condition of activity, but also with the nutritive plane at which the body is to be maintained." One may ask the question then, "What level of nutrition is most advantageous?" The answer is not easy, and it must be sought in metabolism experiments and dietary studies; and it must also be sought in broader observations regarding bodily and mental efficiency, general health, strength and welfare.

According to the earlier views, the protein is built up from peptone through synthesis in the wall of the intestine, since no other tissue in the body has the power of causing peptone to disappear. Conheim teaches that the peptone molecules vanish not because they are built up, but because they are broken down. The site of this synthesis, according to his opinion, is still uncertain, though he holds to the belief that the intestinal wall is where protein synthesis begins. If a complete synthesis of protein does take place in this intestinal wall, it must be a neutral protein, that is, one that is found in the blood. We can hardly conceive of the intestine synthesizing and delivering, in obedience to reflex demands of the various organs of the body, just the particular variety of protein (amino-acids) that is needed.

Lewis once taught that protein was built up from the fragments of the food-protein molecule, not in the wall of the intestine, but in the various organs of the body. If his theory is correct, then the blood would carry molecular complexes of the lower orders from the intestine to the organs sufficient for their local necessities, where these complexes would be built up into the protein of the organs *in situ*, without having to pass through the preliminary stage of conversion into neutral protein. Von Noorden does not agree with this supposition, and holds that the organism is certainly able to convert even specific varieties of the protein of the organs into other kinds, and therefore would be able to build up organ-protein out of neutral protein.

Beyond question, if the organism is able to interchange the proteins of the tissues, which are distinctly, though slightly, differentiated, one can well believe that it has the power to build up specific kinds of protein out of the neutral protein of the blood. Through this physiometabolic process, the intestine would then hand on just half-manufactured stuff made up out of the raw materials it received, but the organs would perfect the work and produce the finished article.

We have seen, from the study of protein metabolism, that *hydrolytic cleavage* precedes every metabolic transformation of protein inside the body. This decomposition goes on in much the same way as it does in the protein of the nourishment in the intestine. In the metamorphosis of protein, decomposition would only be excluded supposing that it consisted exclusively in the annexing of new groups—in a growth of the molecule. "The 'living molecule' of protein in protoplasm, as the bearer of life, the agent and instigator of all body chemical changes, has to enter into a temporary alliance with the lifeless combustible substances, the dispensers of energy, in order to initiate and carry through their oxidation, thus transferring to itself as living force their potential energy. Thus its composition must vary at different moments according to whether it has just annexed such combustible substances in order to oxidize them, or has just given them off again after the combination."

If the accepted theory be that protein is not absorbed in the form of peptone or proteoses, the query arises, "In what form is it absorbed?" If it is admitted that protein invades the blood stream in the form of a molecule larger than the amino-acids, proteose or peptone molecule, it is self-evident, according to Underhill of Yale(48), that

The intestine must be regarded as capable of synthesizing amino-acids into protein. On the other hand, if amino-acids are regularly present in the systemic circulation, the *place* of protein regeneration must be relegated to the cellular elements of the different tissues.

Further:

The belief now generally accepted, as regards the protein requirements of the organism, is that it is not so much the actual quantity as the quality of the protein supplied in the food which is of importance. If the material supplied be uniform, it necessitates a fresh breakdown by each tissue, perhaps by each individual cell. Although the tissues all probably possess the power of breaking down protein material by means of their intracellular proteolytic enzymes, still the extra work involved seems to negative the immediate resynthesis hypothesis, especially when the hypothesis of the circulating digestion product postulates the presence of the individual food material in the blood.

The extensive researches of Folin, Denis, Van Slyke(49) and Myer, and later Abderhalden, have definitely proved the entrance into the blood stream of the amino-acids, which once for all definitely establishes their function—*i.e.*, of being absorbed by the tissues without undergoing any immediate chemical change. While this absorption is rapid, it is never complete, the blood always containing a small quantity of amino-acids. It would appear from this that there is an equilibrium between the amino-acids of the blood and of the tissues. The way in which the amino-acids are taken up by the tissues and held by them is still an unsettled point.

These same investigators, in later researches, sought to determine the ultimate fate of the amino-acids after absorption by the tissues, and selected the changes occurring in the liver, where, after absorption, the amino-acids rapidly disappear. Underhill offers several explanations and suggests the following possibilities: (*a*) The amino-acids may be excreted through the bile; (*b*) they may be transferred to other tissues, though this is highly improbable, since none of the other large organs show any great avidity for amino-acids; (*c*) the absorbed amino-acids are synthesized into body protein in the liver, and (*d*) the amino-acids are deaminized with formation of urea or ammonia.

The amino-acids disappear more rapidly and completely from the liver than from other organs, such as the kidney, spleen, pancreas and intestine. A most satisfactory summary of this whole subject has been made by Van Slyke and Myer(49), which we give below in their own words:

The amino-acids, with perhaps some peptids from the intestine, enter the circulation from which they are immediately absorbed by the tissues. The power to take them up from the blood stream is common to all tissues, but is limited. The muscles of the dog, for example, reach the saturation point when they contain about 75 mgm. of amino-acid nitrogen per 100 grams. The liver, however, continually desaturates itself by metabolizing the amino-acids it has absorbed, and consequently maintains indefinitely its power to continue removing them from the circulation so long as they do not enter it faster than the liver can metabolize them. When the entrance is unnaturally rapid, as in our injection experiments, or when the liver is sufficiently degenerated, as observed clinically in some pathological conditions, the kidneys assist in removing the amino-acids by excreting them unchanged. Death may result when the above agencies for preventing undue accumulation of protein digestion products are overtaxed. In regard to the synthesis of tissue proteins, it appears reasonable to believe that, since each tissue has its own store of amino-acids, which it can replenish from the blood, it uses these to synthesize its own proteins.

From the research experiments of Van Slyke and Myer it may be assumed, says Underhill, that

(*a*) The amino-acids serve as a reserve energy supply, like glycogen, or as a reserve tissue-building material. In either case, the supply would fail unless constantly supplied from the absorption from the intestinal wall. (*b*) The amino-acids are intermediary products in both the anabolism and the catabolism of the tissue proteins. In this case they could originate not only from absorbed food products, but also from autolized tissue protein; starvation would not result in a disappearance of the amino-acid supply of the tissues, and might even increase it.

In order to determine the correctness of either of these assumptions, Van Slyke and Myer carefully analyzed the tissues of animals in various stages of nutrition and concluded that the presence of free amino-acids in the tissues hastened rather than retarded starvation.

In further summarizing, the investigators express themselves as follows:

The amino-acids appear, therefore, to be intermediate steps, not only in the synthesis, but in the breaking down of body proteins. Otherwise, in order to explain their maintenance in the tissues during starvation, one would be forced, contrary to the conclusions of all experimental work on the subject, to assume that they are inert substances lying unchanged for long periods, even when most urgently needed to build tissue or to supply energy. The maintenance of the amino-acid supply by synthesis, from ammonia and the products of fats or carbohydrates, seems excluded. The supply of raw material in the form of fat and carbohydrate nearly disappears during starvation, and the ammonia could originate only from broken-down protein, as the normal store of ammonia nitrogen is only a fraction of that of free ammonia acids. These considerations, and the self-evident wasting of starved tissues, point strongly to autolysis as the main source of the free amino-acids of the fasting body.

The failure to increase the free amino-acid content of the tissues by high protein feeding indicates, furthermore, that when nitrogen is retained in the organism, it is not to an appreciable extent, as stored digestion products, but rather as body protein.

From the foregoing it is no longer questioned that the amino-acids are normally absorbed directly into the blood stream from the intestinal epithelium and distributed to the tissues, and that each tissue rebuilds itself from the mixture of amino-acids thus conveyed to it. Any excess is changed into urea and carbonaceous residues by a process of deamination. Protein material catabolized in the tissues undoubtedly undergoes a series of hydrolytic cleavages, resulting in the formation of amino-acids, and the latter meet the same fate as those produced direct from food protein.

Vegetable Protein.—There is a prevalent belief that vegetable protein is far more difficult of complete digestion than are albuminous substances of animal origin, such as fish, flesh, fowl, milk and eggs. The popular belief of the small percentage of vegetable protein utilized, which is not without foundation, has furnished a strong argument against the vegetable propaganda. Numerous research workers have determined experimentally that the protein content of some vegetables, particularly the coarser cereals and most of the common legumes, is very poorly absorbed.

Atwater and Bryant(50), experimenting along these lines, gathered the following data:

CHARACTER OF THE DIET AND PROTEIN CONTENT UTILIZED

Character of Dietary	Percentage of Protein Utilized
Animal Food	97 per cent
Cereals	85 "
Legumes dried	78 "
Vegetables	83 "
Fruits	85 "
Vegetable Food	84 "
Total Foods	92 "

There are several factors which might help to explain why the nutrients of certain vegetable foods are more difficult of utilization than the same elements from animal foods: (*a*) The low nitrogen content of most vegetable foods requires their ingestion in relatively large amounts; (*b*) this increased bulk of vegetable food with its high cellular content tends to hasten its passage through the intestinal tract, and thereby, to a certain extent, reduce the chances for complete digestion and utilization. In comparison with animal foods the vegetable foods may present an unfavorable texture, especially in the older plants, in which the cell walls may be quite tough and even supplemented with lignin.

There is abundant evidence that cellulose is not digested to any considerable extent by the higher animals. Again, the vegetable membranes are not always readily permeated by the digestive juices. Therefore it is readily understood that plant cells should be thoroughly and effectively comminuted and insalivated as a preliminary step to complete digestion and assimilation.

We must not conclude from the foregoing that vegetable proteins possess any inherent resistance to complete digestion and utilization by the human organism. Mendel and Fine(51) have shown that the two characteristic proteins of wheat, gliadin and glutenin, are as completely absorbed and utilized as the nitrogenous components of fresh beef. The

same probably holds true for the protein content of barley, and to a lesser degree for the proteins of corn. It is regrettable, however, that no such reports are at hand for the isolated proteins of the legumes, beans, lentils and peas.

The newer knowledge of the physiology of the amino-acids emphasizes the fact that each food product ought to be tested on its own merits before any final pronouncement as to its availability and utilization is made. Therefore it will be seen that a protein may be readily digestible, and its digestion products easily absorbed into the blood stream; and yet such a protein may be of inferior biologic value because of its failure to yield all the amino-acids necessary for the nutritive functions of tissue growth and repair. The test, to be conclusive, must be furnished by a physiologic experiment rather than a mere chemical analysis.

VALUE OF WHITE POTATO.—Hindhede(52) of Copenhagen was the first to call attention to the physiologic value of the nitrogenous content of the white potato. Its richness in starch has been long recognized and has led to the inclusion of the potato in the group of carbohydrate foods. Hindhede's research experiments were conducted on men, and were of sufficiently long duration—weeks, rather than days—to give unusual significance to the data collected. He was able, with white potatoes and oleomargarin as the sole ingredients of the ration, to maintain a satisfactory nitrogen balance.

The researches of Hindhede have recently been corroborated by Rose and Cooper(53) at the department of nutrition of Columbia University. The ration for their research experiments consisted of white potatoes and clarified butter. Sufficient quantity was allowed to furnish the requisite fuel value and the potatoes furnished all but 0.1 per cent of the total nitrogen. The nitrogen balance was maintained for seven days on a total nitrogen intake of 0.096 grams per kilogram. This report is in harmony with other experiments in which the nitrogen equilibrium has been maintained on potato nitrogen when the net available energy supply was from 0.04 to 0.08 grams per kilogram of body weight, and effectively demonstrates that the potato is a source of energy of high nutritive efficiency in spite of the fact that only 63 per cent of the potato nitrogen is reported to be in the form of protein.

The unusual prominence of the potato as a food both in Europe and America is due to its palatable carbohydrate content. The researches of careful investigators now emphasize its base yielding inorganic components, and point out its useful function in maintaining the acid base equilibrium of the body(54). The climax is now reached by a most

favorable report on the high biologic value of the nitrogenous components of a food that, heretofore, has rarely been regarded as having any significance whatever as a source of nitrogen.

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CHAPTER VIII

THE SIGNIFICANCE OF LIPOIDS AND VITAMINES IN ANIMAL METABOLISM

IN COLLABORATION WITH

A. BRUCE MACALLUM, A.B., M.D.

Lipoids: Nitrogenous Importance of Lipoids; Lipoids in Metabolism; Bio-electric Potentiality of Lipoids.

Vitamines: Nature of Vitamines; Isolation of Vitamines; Physiological and Pharmacological Properties of Vitamines; Destructive Action of Heat on Vitamines; Antineuritic Vitamines; Vitamines in a Well-balanced Dietary; Rôle of Vitamines in Metabolism; Vitamine Content of Foods; Foodstuffs Containing Vitamines and Their Antineuritic and Antiscorbutic Qualities; Relation of Phosphorus Content to Vitamine Content of Foodstuffs; Vitamines and Pellagra.

LIPOIDS

Nitrogenous Importance of Lipoids.—Proteins and lipoids form the principal component parts of all living cells. Living protoplasm is a mixture of substances and solutions, of a non-homogeneous nature, slightly miscible with each other. Consequently there is a substratum of colloidal material, together with simpler substances of a water soluble nature with an affinity for the colloidal material. It is the oxidation of these substances in aqueous solutions, rather than the colloidal material itself, which liberates the energy manifested in the organism, but the colloidal material makes the conditions and supplies the enzymes which control the energy-yielding oxidations and other metabolic processes. The colloidal materials are produced by polymerization from substances—fats, amino-acids and salts in solution supplied to the cells, but the lipoids are a *sine qua non* to enable most of these substances to enter the cells. Besides, the lipoids are of such importance in the process of nutrition, and together with protein exert such a prominent rôle in all life's processes, that we deem them of sufficient consequence to call attention to their essential activities in the sev-

eral phases in metabolism. They are absolutely indispensable to man and a constant supply is essential to the organism.

The lipoids(1) are a group of organic nitrogenous substances comprising the phosphatids, cerebrosids and cholesterin. The phosphatids contain phosphorus, an organic base, and a fatty acid radicle in their molecule. The members of this series are lecithin, cephalin and cuorin. They are widely distributed in both animal and vegetable cells, but are especially abundant in the yolk of eggs, fish roe, brain tissue, yeast, blood and bile. They are also found to a lesser extent in cereal grains, legumes and beet root. The cerebrosids are isolated almost entirely from brain and nerve tissue. These do not contain phosphorus and yield galactose upon hydrolysis with dilute mineral acids. Cholesterin is an unsaturated secondary alcohol, is universally present in animal and vegetable tissue, and is most abundant in bile, yolk of eggs, nerve tissue and wool fat, and found abundantly in wheat, barley, beans, peas, lentils, carrots, peanuts and beets.

Lipoids in Metabolism.—The importance of the lipoids in mammalian nutrition is illustrated by the fact that the growth of the brain is directly proportionate to the lecithin content of the mother's milk. A number of investigators have asserted that the lipoids are essential for the maintenance of life and growth, but when lipoids in a comparatively pure state are added to lipoid free diets, no beneficial results follow. In these cases where the lipoids were extracted from the food before feeding it to animals, the vitamine fraction was removed along with the lipoids and for this reason the purified lipoids gave no relief to the symptoms resulting from the use of the lipoid free diet. Cholesterol is also an essential factor in metabolism, as Landers'(2) experiments prove that it cannot be synthetized by the mammalian animal tissue and it is promptly incorporated from the diet and tenaciously retained by the body when animals are on a lipoid free diet. He demonstrated anew that pure cholesterol added to a lipoid free ration resulted neither in increment of growth of the young nor maintenance of life. Fowls on the other hand can synthetize lipoids or their mother substances from a lipoid free diet(3). The lipoid group in the normal diet, apart from its function as a source of absorbed vitamines, is of importance in replacing the lipoid deficiency following the lipoid catabolism.

Lipoids are easily permeable by substances soluble in fat, but it is with the greatest difficulty that they are permeated by solutions of salt, sugar and similar substances. The amino-acids are lipoid solvents(4) and their method of entering the cells is through the lipoid spaces in the outer layer

of the plasma membrane of the cells. Meyer is the authority for the statement that these peculiar lipoids which intersect and surround the living protoplasm with walls of froth, so to speak, are of decisive importance in the life and functions of the cells. It is claimed that their presence prevents a fusion of the innumerable particles of the cell, and at the same time they protect it against a too rapid ingress and egress of water, as well as against invasion by salts and other substances dissolved in the blood and organic fluids. Besides this, they possess another function of acting as a sort of sieve for all the substances soluble in fat, and for those which dissolve in them more readily than water.

Bio-electric Potentiality of Lipoids.—According to Loeb and Beutner(5) the lipoids confer on the cells the property of bio-electrical potentiality. Lillie(6) has shown that the cells owe the property of irritability, or the power of responding to the various stimuli, to the lipoids. Therefore, the great importance of the lipoids in the organic processes of the cells becomes apparent to the student of tropho-dynamics. Moreover, it is in accord with Schauman's phosphorus-deficiency theory of beriberi, pellagra and other deficiency diseases.

VITAMINES

Nature of Vitamines.—Vitamines is a term first applied by Funk(7) to certain substances of undetermined structure which occurred in the outer parts—pericarp—of cereals, and we are especially indebted to him for pioneer work in this particular field. Cooper(8) holds that vitamines are neither proteins, fats nor lipoids, and there is no evidence that they are carbohydrates; so they cannot yet be classed with either protein, carbohydrate, fats or salts, though the teaching at the present time seems to suggest that they may enter into the molecule of certain lipoids. This belief is emphasized by Carl Voegtlin(9), who has done considerable experimental research on the subject. Some investigators are inclined to the opinion that there are different vitamines which are active in preventing disease—one for beriberi, one for scurvy, one for pellagra, etc. Vitamines are present in foodstuffs in such exceedingly small amounts that they cannot, it seems, have any caloric value, and yet they are positively essential to health, growth and development.

Isolation of Vitamines.—We are indebted to Funk(10) for first devising a method of obtaining the antineuritic vitamine in a more or less pure form of very powerful physiological activity. He was able to isolate a crystalline substance, a few milligrams of which administered to a polyneuritic pigeon (experimental beriberi) led to a complete recovery of the paralytic

symptoms in a very few hours. According to Funk, this crystalline substance seems to have a melting point of 233° C., and, on analysis, contains carbon, nitrogen, hydrogen and oxygen. It is regrettable, though, owing to defective methods, that the yield in this active substance is very poor, only a very minute quantity being obtained from hundreds of pounds of natural foods, rich in these accessory bodies.

At the present time the antiscorbutic vitamine has not been isolated, and about all that is known to-day is that it is fairly stable in acid media which probably accounts for the popularity of lemon juice as an antiscorbutic. For the same reason milk, having an amphoteric reaction, on being heated for a considerable time to a temperature exceeding 212° F., loses its antiscorbutic properties, and when forming the exclusive diet for children may give rise to the appearance of infantile scurvy.

Physiological and Pharmacological Properties of Vitamines.—The physiological and pharmacological properties of the vitamines have not been studied extensively. The principal points which have been established are that they do not possess toxic properties, and that even in remarkably infinitesmal amounts, they relieve the symptoms of deficiency disease in both man and animals.

Funk(11), Braddon and Cooper(12) have recently pointed out the interesting relation between carbohydrates and the antineuritic substances. They found that in order to prevent the occurrence of polyneuritis (experimental beriberi) in pigeons, it was necessary to administer to the bird an infinitesmal quantity of antineuritic substance for each gram of carbohydrate in the diet of the pigeon. It was further found that when the carbohydrate component of the pigeon's diet was increased, the vitamine content also had to be increased accordingly. These discoveries emphasize the earlier observations, that a diet rich in cabohydrate is more apt to give rise to the appearance of the symptoms of beriberi than a diet poor in carbohydrate.

The table on page 226, from Voegtlin(13), graphically illustrates the relative vitamine content of foods, showing in the order arranged the foods that are richest in both the antineuritic and antiscorbutic vitamines. It is not intended that this table be taken as absolutely accurate, but, at the present time it is as accurate as the present state of our knowledge will permit, and may be of value in helping to elucidate the question of the proper selection of foods to constitute a satisfactory dietary for the deficiency diseases.

Destructive Action of Heat on Vitamines.—From the conclusions of research workers in this particular field of biology, we may assume that

the antineuritic vitamine is present in foods in a combined form, which is much more resistant than the free curative substance. This is of momentous importance as, in the process of cooking, the food is subjected to a temperature of 212° F., but beyond this degree up to 266° F. for any considerable length of time, the vitamines are completely destroyed. Vitamines are fairly susceptible to temperatures above 100° C. (212° F.).

Various experiments(14), conducted on both man and animals, show that the prolonged heating of foods to a temperature of 120° C. (270° F.) for one to three hours will destroy most of the physiological activity of the vitamines originally present in the foods. Funk has recently experimented with canned beef, and found that when fed to a dog to the exclusion of all other aliment, the animal died in two weeks' time.

Antineuritic Vitamines.—Funk, who has done more work on this subject than any other investigator, succeeded in obtaining a small quantity of antineuritic vitamine from dried ox-brain; later Voegtlin and Towles succeeded in demonstrating its presence in crude extracts from the spinal cord. It would appear probable, therefore, that the antineuritic substance forms an essential part of the nerve cell and fiber, and that its presence in nerve tissue in sufficient amount is essential for proper function of the spinal cord. Degeneration of the nerve tissues will take place whenever the vitamine content of the nerve tissues is depleted through a dietary deficient in vitamine. Voegtlin(15) has emphasized the fact that lipoids and antineuritic vitamine are proportionately distributed throughout the body, possibly due to the lipoid solubility of the antineuritic vitamine. The animal body seems to have a peculiar tenacity for holding on to its vitamine supply, for the latter author quoted says:

> If we change the diet of man from one sufficient in vitamine to one deficient in vitamine, we find as a rule, it takes several weeks or even months before obvious and well-defined symptoms of deficiency diseases appear. One might ask why the body does not react more rapidly to a deficient diet. Apparently the initial vitamine content of the body, which in absolute terms probably amounts to only a few grams in a person weighing 100 pounds, is not easily used up or eliminated together with their excretions. The catabolism of vitamine, if there is such a thing, must be extremely slow. If vitamines do occur in the colloidal state, and a number of facts seem to prove this assumption, it is very likely that certain other body colloids may fix vitamines in the tissue fluids by means of absorption.

Traube(16) has attempted to show that certain alkaloids with very powerful and prolonged physiological action occur in the form of colloids.

> The fact that these substances are colloidal may be one of the reasons for their powerful physiological activity, especially as the recent teachings of bio-chemistry

seem to support the view that life itself is largely dependent on the colloidal state of living matter.

Vitamines in the Well-balanced Dietary.—Ever since Stepp(17) demonstrated that the growth-promoting element in the diet could be removed by extraction with alcohol, the lipoids, which constituted the bulk of the extract, were supposed to be the factors which enabled the animal body to attain adult size and weight. The subsequent researches of Funk on the etiology of beriberi revolutionized some of the current conceptions of nutrition and indicated a new avenue of approach towards the solution of animal growth. The plan, which proved so successful in the antineuritic investigation, was applied to the elucidation of the growth problem(18). The experimental evidence accumulated since then is now sufficient to substantiate the vitamine theory in regard to this important phase of animal physiology.

Stepp also has advanced the opinion that vitamines and lipoids are the two essential factors in nutrition during the growth period(19). The physiological activity of these growth-inducing fractions from yeast and pancreas depreciates with each successive step in the preparation of the active fraction, as in the case of antineuritic vitamine; and considerably larger quantities are necessary to enable the animal to attain its customary growth increment than are required to effect a cure in the case of polyneuritic pigeons. These growth "vitamines" or "accessories" do not in themselves directly stimulate the growth of the animal cell. Their action in this respect consists in each and every specific vitamine being present in a diet otherwise adequate, and playing their part in maintaining the metabolic equilibrium. In this way the maintenance of the normal physico-chemical conditions is established, since the nucleus and protoplasm of the animal cell possesses the inherent capacity to grow and reproduce when adequately nourished. It is yet to be proved that there is any factor in the diet which alone can bring about growth of any animal cell for lengthy periods, in the strict sense of the term "specific growth substance."

Careful experimental research has emphasized the fact that each individual needs a different amount of food, which will vary according to his structure and surroundings; he will need certain types of protein, carbohydrates, fat and salts, in addition to water, and finally he must have other substances, generically called vitamines, if he is to show physical growth.

Rôle of Vitamines in Metabolism.—The study of dietetics from the point of view of the vitamines has only just begun, and the exact rôle they

play in metabolism has not yet been elucidated, but it has been clearly demonstrated that certain deficiency diseases are due to the lack of certain accessory foods. Pellagra, beriberi, scurvy and other deficiency diseases are to be controlled or prevented through the administration of the proper foods containing the adequate vitamines(20). A number of foods and dietary rules for use in order to prevent these deficiency diseases have been outlined in these pages(21). In any institution where bread is the staple article of diet, it should be made from whole-wheat flour. Rice used in any quantity should be of the brown undermilled variety. Beans, peas or other legumes known to prevent beriberi, should be served at least once a week. Canned beans or peas should not be used. Some fresh vegetable or fruit should be issued at least twice a week, and barley, a known preventive of beriberi, should be used in all soups. Corn meal should be of water-ground variety, i. e., made from the whole grain. White potatoes and fresh meat should be served at least once a week, preferably once daily, as they prevent scurvy and beriberi. The undue use of canned goods must be carefully avoided(22).

Fortunately, in this country, the majority of the inhabitants live on a fairly well mixed dietary, and thereby escape outbreaks of beriberi and scurvy. According to the opinion of Dr. Carl Voegtlin(23), of the United States Public Health Service, who has conducted extensive research along this line of experimentation, it seems fairly well established that the substances preventing beriberi are present in the natural foods largely in a combined form, which is soluble in 90 per cent alcohol or water, and when present in sufficient quantity in the alimentation will prevent the occurrence of beriberi.

This mother substance can be split off by acid hydrolysis or autolysis, by means of enzymes yielding after fractionation a substance with very powerful curative property, which if given patients suffering from beriberi, will relieve the distressing symptoms in a very few days.

At the present time very little is known of the chemical nature of the mother substance of this beriberi vitamine. It is interesting to note that the latest researches seem to point to the fact that foods rich in lipoids are also rich in vitamines, and the observations of Sullivan and Voegtlin(24) call attention to the fact that "the solubility of the mother substance of the antineuritic substance in alcohol, might lead to the belief that vitamines enter into the molecule of certain lipoids." They also hold that the antineuritic vitamine is probably not in combination with carbohydrates, since the starchy part of all cereal foods seems to be very poor in this sub-

stance. Some competent observers hold to the view that certain parts of the protein molecule, more especially the nucleic acids, may possibly hold in combination the active "accessory substances," but this is still an unsettled question. The fact that foods rich in nucleated cells are also rich in antineuritic substance, might, perhaps, be accepted as evidence of the truth of this assumption.

Vitamine Content of Foods.—Vitamines are contained in varying proportions in all food products, some food constituents being rich in them and others very poor. Again, in other foods, the vitamine is abstracted or destroyed in the various processes of preparation and cooking. An ordinary mixed diet contains enough vitamine to sustain nutrition. Unless the food contains sufficient vitamine principles, no matter how large quantities are consumed, there will be malnutrition. This is the case among the poor, who consume large quantities of food which is neither proportionately balanced nor sufficiently varied to furnish the requisite vitamine content. For this reason diseases of malnutrition are common.

The animal body is unable to produce the known vitamines from vitamine-free food. All the higher animals, including man, according to Voegtlin(25), get their vitamine supply directly or indirectly from the vegetable kingdom. Plant life synthetizes the vitamine, and man obtains the required vitamine supply by partaking either of animal or vegetable food. The cow stores up vitamine in her body from grasses, grains and fodder, which she consumes. A portion of it is excreted in her milk, sup-

RELATIVE VITAMINE CONTENT OF FOODS

Antineuritic Properties		Antiscorbutic Properties	
Relatively Rich	Relatively Poor	Relatively Rich	Relatively Poor
Brewer's yeast	Sterilized milk	Fresh vegetables	Dried vegetables
Egg yolk	Sterilized meat	Fresh fruits	Dried fruits
Ox heart	Cabbage	Raw milk	Sterilized milk
Milk	Turnips	Raw meat	Canned meat
Beef and other fresh meat	Carrots and other vegetables of this type	Cereals sprouting	Dried cereals
Fish	Highly milled cereals		Pork fat
Beans	Starch		Starch
Peas	Pork		Molasses
Oats	Molasses		Corn Sirup
Barley	Corn Syrup		
Wheat			
Corn and other cereals			

plying the calf with necessary vitamine, and at the same time furnishing a valuable source of vitamine for man. The hen derives vitamine from the cereals she eats, and transfers a part of it to the eggs she lays. The vegetable kingdom, therefore, furnishes the vitamine supply so essential to animal life, and the plant laboratory builds up vitamine from simple inorganic compounds.

A careful study of the table on page 226 shows that a mixed diet can be outlined which will include sufficient animal foods, such as fresh milk, eggs, meat and a variety of fresh vegetables containing sufficient anti-neuritic and antiscorbutic substances to make a satisfactory well-balanced mixed dietary. Ordinarily the dietary habits of the major portions of the population of this country are such that sufficient fresh animal and vegetable foods are consumed to overcome any deficiency of vitamines in the diet.

Prior to 1878 wheat and corn were ground on the old-fashioned buhr millstones ("water-ground") to the desired degree of fineness. The resulting wheat flour or cornmeal, from which the coarser particles of bran were partially sifted out, was then used for making bread. Such bread contained 1.75 per cent cereal salts, all that was in the grain when it left the harvest field, while the new patent roller-process flour of to-day contains 0.44 per cent mineral matter. During the past five or six decades the milling industry has completely revolutionized the grinding of grains. By means of the patent roller-process it has been made possible to separate the various parts of the grain, the germ and the bran, from the endosperm, or starchy part, which could then be ground to the desired fineness, and which, on account of its whiteness, appealed to the public as an assumably purer product. It is admitted that the "highly milled" wheat flour and corn meal obtained by the patent roller-process are superior, so far as looks and keeping qualities are concerned, to the old-fashioned water-ground products; but at the same time, unfortunately, this modern method of milling deprives the finished products of some of the most valuable food constituents of the grains. The Bureau of Chemistry of the Department of Agriculture and the Hygienic Laboratory have made a large number of analyses of highly milled wheat flour and corn meal, which clearly show that the highly milled wheat flour and corn meal contain less protein, less fat and less cereal salts than the old-fashioned water-ground product.[1]

The highly milled products from wheat, corn and rice are deficient in the essential accessory food substances, vitamines, which, as previously

[1] *See* Corn, Corn Products and Grinding, Volume I, Chapter XIII, pages 392-396.

pointed out, are contained in the intact kernel in the outer pericarp, or aleurone layer, and probably also in the germ or embryo. As pointed out, the modern roller process eliminates, to a great extent, the bran and germ, and as a result the highly milled product, as might be expected, is deficient in vitamines, which assumption has been amply proven by recent investigations conducted by Funk and his coworkers, and later by Myer and Voegtlin of the Public Health Service(26).

Foods Containing Vitamines and Their Antineuritic and Antiscorbutic Qualities.—Laboratory experimentation(27) has proved that *butter-fat* promotes the normal growth of young rats, while, under the same dietary conditions, lard and some other fats fail to do this(28). Therefore, the question has arisen, "What is the special constituent of the butter fat which aids normal growth and development?" Osborne and Mendel(29) question the presence of nitrogen and phosphorus in the butter-fat used in their feeding experiments, McCollum and Davis(30) question the absence of nitrogen and phosphorus from this fat, and Otto Folin agrees with the latter, stating that there was extracted a trace of nitrogen equal to 0.2 mg. from 10 grams of butter-fat. Funk and Macallum(31) succeeded in obtaining nitrogen from centrifuged butter-fat, in small amount, equal to 31 mg. nitrogen (16.8 — 14.0 mg.) from 12 kilograms of butter-fat. Gies, of New York, reports that from 21.3 grams of butter-fat he was able to isolate phosphorus in infinitesmal amount. From the researches of Funk, Osborne, Mendel, Davis, Macallum and their followers, butter-fat undoubtedly contains a growth promoting substance which may be an accessory food substance or vitamine. It is a well-known fact that butter contains about 15 per cent of buttermilk (see analysis, Volume I, Chapter XII, page 336), which is rich in both phosphorus and nitrogen. This growth-promoting substance in butter-fat belongs, in all probability, to the same class of so-called "accessory dietary constituents." We do not know at the present time whether or not this substance is identical with some vitamines, but the presumption is that this is the case. Later researches demonstrate, however, that butter-fat possesses no antineuritic vitamine, and that its action is in part antiscorbutic, in addition to a second factor as yet indefinable(32).

Rice has long been regarded as an etiological factor in the causation of beriberi, and modern research and clinical experimentation has at last satisfactorily settled the question affirmatively. As previously stated (Volume I, Chapter XIII, page 391), the rice grain contains an outer covering or chaff, beneath which is a husk or pericarp surrounding the subpericarpial or aleurone layer, which in turn encloses the main central part of

the grain or endosperm, consisting chiefly of starchy matter. The vitamines are present in the subpericarpial or aleurone layer. The vitamine is a nitrogenous substance, but lacking in phosphorus. It is soluble in water, alcohol and dilute acids. It is undoubtedly destroyed by heat above 212° F. Machine polished rice consists solely of starchy endosperm, the pericarp, subpericarpial or aleurone layer being completely removed in the polishing processes. This rice is the ordinary commercial white rice, and is devoid of vitamine, and birds fed on such rice will rapidly develop polyneuritis, which will prove fatal. Human beings subsisting on a dietary composed largely of polished rice will develop beriberi, unless the other adjuvants of the diet supply the requisite amount of vitamine. Rice from which the husk or chaff is removed by steaming or treatment with hot water (parboiled rice), subsequently rubbed in a mortar by hand and afterwards prepared for human consumption, will not produce beriberi, for the reason that during the crude method of milling, a large percentage of the subpericarpial or aleurone layer, which contains the vitamine substance so essential to the dietary, is left adherent to the grain.

According to Wilcox(33):

> In animals in whom polyneuritis or beriberi has been caused by feeding on polished rice, the symptoms quickly clear up if the native unhusked rice—i. e., the rice from which the husk has not been removed by previous treatment with steam or hot water—is substituted for the polished rice. Instead of this, the addition to the polished rice of an extract of the rice polishings will have the same beneficial effect. the *katjang idjoe* bean also contains anti-beriberi vitamine and its addition in amount of ½ lb. a day to a polished rice diet will prevent beriberi in natives.

F. Gowland Hopkins(34), in his recent researches to determine the important part played by vitamines in metabolism, has confirmed the conclusions of Funk(35), Fraser, Stanton, Eykman and Cooper of definitely establishing the important fact that beriberi is essentially a deficiency disease. Modern clinical research on metabolism has conclusively proved that a diet of pure protein, fat and carbohydrate, with a due allowance of proper admixtures of salts and water, is not sufficient to maintain health, though the quantity allowed may be theoretically correct. A growing animal fed on the above ternary food principles with proper mineralization will cease to grow and will develop some deficiency disease, such as beriberi, scurvy, etc. Some other addition to the dietary is vitally necessary, if the animal is to maintain health and thrive. Many natural foods contain these essential substances which need only be present in the most minute amount, in order to make the diet amply sufficient for growth and health. *Yeast,* for instance, is a substance which is perhaps richest in

vitamine. The *yolk of eggs, brain, liver, kidneys, sweetbread, oatmeal, haricot, beans, peas,* etc., are all fairly rich in this vitamine substance, while *milk* and *fresh meat* contain vitamines in smaller amounts. The subpericarpial or aleurone layer of rice is richer in organic phosphorus than the endosperm, and, as a result, it has been found that rice poor in phosphorus is more likely to cause beriberi (polyneuritis of fowls) than whole rice.

A dietary deficient in these accessory substances gives rise to beriberi, which is a disease of the peripheral nervous system, prevalent in eastern countries, Japan and the Philippines, where the inhabitants subsist almost entirely upon a diet composed largely of highly milled "polished rice." It is believed that even in our own country an alimentation composed almost entirely of foods from highly milled wheat—"patent roller-process flour," would produce beriberi in ninety days; in fact, Little(36) reports an outbreak of beriberi among the fishermen of Newfoundland, who subsisted mainly upon alimentation composed largely of highly-milled patent roller-process flour. It is known that beriberi does not develop in persons living on foods made from whole-wheat flour or from whole rice. In other words, as previously pointed out (Volume I, Chapter XIII, page 377), the outer portions of both the wheat and rice grain, namely, the subpericarpial or aleurone layers, contain the "accessory substances" or vitamines which are so essential to the dietary—for the prevention of disease of the peripheral nervous system (beriberi and pellagra). Likewise research by competent observers in cases of scurvy has established the fact that beriberi is not due to a deficiency of the ternary elements of the dietary proteins, fats and carbohydrates, but to certain accessory food substances highly essential to life lacking in the alimentation. Consequently beriberi, pellagra and scurvy are referred to as deficiency diseases. (See chapter on Deficiency Diseases, Volume III, Chapter XVII.

The consensus of opinion of research workers in deficiency diseases, Fraser and Stanton(37), Strong and Crowell(38), in the Philippines, Van Leent(39), Vorderman(40), Takaki(41), Fletcher(42), Highet (43), Heiser(44), Theze(45), Chamberlain(46), Vedder(47) and others, since the appearance of Funk's work on the vitamines, is that beriberi is a disease caused by dietary deficiency resulting from faulty metabolism, due to the lack of the vital accessory food substances to which Funk gave the name "vitamines."

Working along this line of research, Williams(48) and Seidell have found that a similar isomerism existing in these substances also exists in

the vitamine of yeast, and is primarily responsible for the instability of these compounds, which has so far prevented their isolation. Adenin is the purin base in yeast, which has this property of isomerism. With regard to the antineuritic vitamine, Vedder has proposed the hypothesis that this chemical substance acts as a building stone of the complex structure of the nervous tissue, without which it cannot be repaired.

All of the foregoing investigators have succeeded in obtaining from rice polishings a chemical substance which in doses of a few milligrams, was capable of curing fowls suffering with polyneuritis induced by a diet of overmilled rice.

When a deficiency of vitamine exists, the nervous tissue becomes first exhausted, and then degenerated until finally the symptoms of polyneuritis appear in fowls or dry beriberi in man. This theory is based on experimental observations in man.

Thus Vedder and Clark(49) found that the mitochondria in the nerves of fowls showed definite changes after seven days on a diet of polished rice, and long before the fowls showed any clinical symptoms of polyneuritis, and these changes were progressive the longer the deficiency lasted until evident degeneration could be demonstrated. Chromatolysis and changes in the tigroid substance of the cells of the cord, similar to that observed in pigeons which have been exhausted by long flights, may also be demonstrated in birds which have developed polyneuritis.

The antineuritic vitamine is the only one of the accessory food substances concerning which there is sufficient evidence to even theorize concerning its action in the body, and more work will be needed before any adequate conception of the physiological action of the vitamines will be known. The study of beriberi, scurvy, and other deficiencies has given a working basis that there are a number of different accessory food substances or vitamines and that each deficiency disease is caused by the absence of its particular vitamine.

Vedder, from his own experiments and those of other investigators, considers that we must assume that there is a whole group of these vitamines, but that further investigations will be necessary to determine the relation of these various substances to each other.

To a limited extent, in the mountainous sections, water-ground wheat flour and corn meal are still produced on the old-fashioned buhr millstones. This water-ground flour and meal contains practically all of the vitamines and all of the mineral salts of the whole grain, while the highly milled products are decidedly deficient both in the cereal salts and in these highly essential accessory substances.

Three or four decades ago all grain, especially in the South, was

ground at the neighborhood mill on the old-fashioned buhr millstones, and the power was furnished by the nearby stream. By this method of milling, now almost entirely replaced by the steam or electric patent roller-process, only the coarser particles of the bran and outer skin or husk were removed.

Two years ago the author [1] spent a vacation of two months in his native state, North Carolina, and took occasion to investigate the incidence of pellagra in counties far removed from railway accommodations, particularly in western North Carolina, eastern Tennessee and Kentucky. The inhabitants of these sections are too far removed from railway facilities to purchase roller-process meal, and must send their corn to the nearby neighborhood mill, where it is ground in small quantities at a time, sufficient for immediate needs, and the whole meal is eaten, furnishing the necessary vitamine substance. The families living in the lowland section, convenient to railroads, buy their supply of patent roller-process meal at the village store. This is devoid of the accessory vitamine substance, and unless the dietary is augmented by fruits, vegetables, milk or fresh meat supplying the accessory substance, deficiency disease will soon follow.

Wood (50), writing on pellagra, has observed that in an eastern county of North Carolina, remote from railroad facilities, broad areas with thousands of inhabitants are free from pellagra. The inhabitants of this locality consume as a food large quantities of corn meal, but it is a whole meal water-ground product.

Many experiments have been conducted [2] (51) to determine the correct physiological estimation of the vitamine content of foods, and from the available data collected it is safe to assume that a perfect analogy exists between the well-known relation of polished rice to its nutritive value and the high milling of wheat and corn to the nutritive value of wheat flour and cornmeal. It is an accepted fact, proved by numerous investigations, that if the alimentation of a people is principally composed of highly polished rice, and otherwise deficient in vitamines, beriberi will develop, but on the other hand, if undermilled rice is substituted for the highly milled product the disease is not so likely to develop.

The extreme importance of a method for determining the vitamine content of foods, and of isolating these all important accessory substances is quite apparent.

According to Funk, the vitamine theory is so new that "little progress has been made thus far in the isolation of the vitamine principle in suffi-

[1] Dr. Fitch. [2] At the Hygienic Laboratory, Washington, D. C.

cient quantities to be of value therapeutically, because most of the vitamine was lost, destroyed or rendered inert in the processes of isolation." Recent investigations carried out in the Hygienic Laboratory(52) on the vitamine content of brewer's yeast, gives hope of better results. In the past, the great difficulty had been to isolate the vitamine in sufficiently concentrated amounts to make it of practical use therapeutically. This problem has at last been solved by the use of Professor John Uri Lloyd's prepared hydrous aluminum silicate(53); which has a very high selective absorptive power. It was found that 0.05 gram of this solid vitamine product would keep in health a 300-gram pigeon fed exclusively on polished rice or would cure in a very few hours pigeons that had already manifested symptoms of polyneuritis on a polished rice diet. Control pigeons fed on polished rice and untreated with vitamine soon died with polyneuritis. According to research workers in the Hygienic Laboratory, it would seem that a proportionate dose of vitamine for a man weighing 122 pounds would not exceed 10 grams, which could easily be taken in capsule or other form for therapeutic or preventive purposes. It is now to be hoped that the isolation of vitamines from other food products rich in them will soon be accomplished.

Relation of Vitamines to the Phosphorus Content of Foods.—Unfortunately, a method for the direct isolation of vitamines from natural foods has not been devised, as in the case of yeast. However, the phosphorus content of natural foods seems to furnish a fairly accurate index of the relative percentage of vitamines present. Voegtlin, Myers and Sullivan(54) have been able to determine that while phosphorus does not form a component part of the vitamine molecule, yet it seems, according to their views, that the distribution of phosphorus and vitamines within the grain runs practically parallel.

Tibbles(55) in summing up the arguments of Schauman in favor of the phosphorus deficiency theory as a factor in the causation of deficiency diseases records the following: (a) that foods which cause beriberi, ship beriberi, scurvy and infantile scurvy are deficient in organic phosphorus, and (b) that the diseases are cured by foods rich in organic phosphorus compounds. It is probable that different groups of organic phosphorus compounds serve different purposes in the organism, and that their absence leads to different diseases. Deficiency of one organic group may cause beriberi in adults, and deficiency of another group may cause rickets and infantile scurvy. Children fed with boiled or condensed milk sometimes develop scurvy-rickets. When milk is boiled it is to some extent denatured; the organic compounds of phosphorus are more or less de-

stroyed. Bunge says lecithin is destroyed at 70° C. (140° F.). Raczowski found 25 per cent was destroyed at 60° C., 28 per cent at 95° C., and 30 per cent at 110° C. Rickets is common in children of the poor in England, less common in the highlands of Scotland and in Ireland. Many English children are fed on skim milk containing only 0.03 per cent of phosphorus pentoxid (P_2O_5), white bread containing 0.2 per cent phosphorus pentoxid and margarin. A Scotch highland child gets oatmeal containing 0.9 per cent phosphorus pentoxid and new milk containing 1 per cent phosphorus pentoxid, and German children get rye bread containing 1 per cent phosphorus pentoxid.

Edie and Simpson(56) found that these diseases are not cured by the addition to the food of carbohydrates, inorganic phosphates, egg albumin and synthetic organic phosphorus compounds, such as glycerophosphates, albumin, metaphosphates, etc., nor did these substances prevent polyneuritis in birds. But polyneuritis in birds is prevented and cured by the addition to the diet of substances rich in organic phosphorus, such as rice bran, wheat bran, yeast, *katjang idjoe* beans, testicular extract, pancreas, etc., in such proportion as to raise the daily income of phosphorus in the food to the normal amount. The daily normal requirement for a man is 2 grams, for a dog 0.5 gram. It was found by Fraser and Stanton(57) that the beriberi causing power of rice is associated with the removal of the phosphorus-containing substances by polishing the grain. They have definitely proved that no rice connected with the outbreak of beriberi contained more than 0.26 per cent of phosphorus pentoxid, that rice which contained 0.37 per cent of phosphorus pentoxid did not cause beriberi, and the consumption of rice containing 0.4 per cent of phosphorus pentoxid is perfectly safe.

More recent evidence is afforded by a Siamese Government Report on beriberi by Highet, which furnishes conclusive evidence that the use of rice containing less than 0.4 per cent of phosphorus pentoxid is likely to cause beriberi. If not milled so as to reduce the phosphorus pentoxid below this standard, Siamese rice is a safe food. Acting on this finding, the Siamese Government pushed the use of under-milled rice in all government institutions and the *gendarmerie*, and has practically done away with beriberi among these people, and an attempt is now being made to enforce its use in the army and navy.

Fraser and Stanton(58), basing their opinion on a large number of observations and analyses, conclude that rice with a phosphorus pentoxid (P_2O_5) content below 0.4 per cent is deficient in vitamines. Myers and Voegtlin adopted this method to correlate the vitamine content of wheat

and corn products, and came to the same conclusion, that the identical relation exists between the phosphorus pentoxid content of these cereals as exists in the case of rice. To arrive at this conclusion, they conducted a series of experiments on fowls, the classical animal for determining the vitamine content of foods. It is well known that fowls will live in perfect health for many months on an exclusive diet of wheat or corn.

Whole corn meal, or the so-called "water-ground" corn meal, furnishes a well-balanced dietary for fowls, but, on the other hand, it is a matter of recorded fact that fowls fed on highly milled products from wheat, corn or rice will die within a month or six weeks from polyneuritis. The following table from Public Health reports graphically illustrates the findings of Voegtlin and his coworkers:

TABLE SHOWING THE EFFECT OF WHOLE GRAIN AND HIGHLY MILLED CEREALS ON FOWLS

Variety of Cereals, Whole and Highly Milled	Per cent of P_2O_5 dry food	Number of days required for appearance of polyneuritis in fowls fed exclusively on this food
Wheat bread made from highly milled flour	0.114	20–32 days
Whole wheat	1.120	No symptoms developed
Corn grits (highly milled)	0.169	23–50 days
Corn grits (highly milled)	0.210	30 days
Corn meal (highly milled)	0.30	35 days
Corn meal (old fashioned rock ground)	0.659	Remained well
Corn meal (rock ground)	0.772	Remained well
Corn germ	2.816	Remained well
Corn, whole	0.760	Remained well

Myers and Voegtlin conclude from their experiments the following provision standard, phosphorus pentoxid content for wheat, flour, corn meal and grits; for corn products, the minimum phosphorus pentoxid content should not fall below 0.50 per cent and for wheat flour not below 1 per cent, as a safe index for arriving at the relative amounts of vitamines present. These investigators consider the determination of the phosphorus pentoxid index of considerable value in all cereal products with the exception of the so-called "self-raising flours." These latter products contain baking powders, composed largely of phosphates. Of recent years certain factors have arisen which exert a tendency to limit the vitamine content of the dietary of certain classes of our rural population. Changes in the economic conditions of food production and the methods of cooking

seem to reduce the vitamine content of the diet of a large number of persons almost to the danger point. One factor involved in the reduction of the vitamine content of bread, especially cornbread, is the almost universal use of baking soda as a leavening in bread making. It has been clinically demonstrated on animals that bread made from highly milled corn meal, to which milk and soda is added for leavening, lessens the high initial content of the antineuritic substance during the process of baking as a result of the destructive action of the alkali contained in the soda.

We pointed out in the section on Bread Making (Volume I, Chapter XIII, page 386) that, where bicarbonate of soda and milk are used for leavening during the process of cooking, the sodium bicarbonate was converted into a strong alkali, which is not a food product. Prior to the introduction of the patent roller-process of grinding grains, cornbread made from the water-ground meal was mixed with salt and water and it yielded a wholesome bread; but simultaneously with the introduction of highly milled corn meal, it was found that when this product was mixed with salt and water, it did not yield bread of the same lightness as the old-fashioned water-ground meal. It then became necessary to resort to artificial leavening, and sodium bicarbonate became a popular household remedy. Bread, made by means of bicarbonate of soda and salt, under present conditions, has a distinctly alkaline taste and reaction. The usual method of preparing bread from bolted corn meal is to mix it with water and add a small quantity of shortening and bicarbonate of soda for leavening. The resulting mushy mixture is baked in an oven, the high temperature of which liberates carbon dioxid from the sodium bicarbonate, and the latter is transformed into sodium carbonate, a strong alkali. Voegtlin and Sullivan(59) recently demonstrated that the action of this alkali is destructive to vitamines(60). It was then definitely proved that the "accessory substances" lose their physiological activity when exposed to alkalies, and more especially under the influence of the high temperature of a baking oven. Cornbread, prepared from the old-fashioned water-ground meal, sweet milk and soda, when forming the exclusive diet of chickens, soon leads to the development of symptoms of polyneuritis, but on the other hand, bread prepared from the old-fashioned water-ground corn meal, buttermilk and salt (NaCl) does not give rise to any polyneuritic symptoms, and the fowls seem to maintain perfect health. In contrast to the destructive action of alkalies on vitamines brought about by the use of bicarbonate of soda in bread-baking, it is necessary to emphasize the fact that the old-fashioned way of combining baking soda with sour buttermilk in the preparation of bread is a perfectly harmless procedure, provided that

sufficient sour milk is added to neutralize the alkalinity of the baking soda.

The following table worked out by Voegtlin emphasizes the destructive action of baking soda on the vitamine content of cornbread. He fed a coop of chickens on cornbread having the following composition:

600 gm. of corn meal
800 c.c. sweet milk
10 gm. of baking soda

with the following result:

Laboratory Numbers of Animals	Number of days before appearance of polyneuritis after feeding was begun	Laboratory numbers of animals	Number of days before appearance of polyneuritis after feeding was begun
31	13	37	19
32	14	38	21
33	27	39	18
34	13	40	16
35	22	..	..
36	14	Average	17

Vitamines and Pellagra.—The appearance of pellagra, a disease of the peripheral nervous system, has recently stimulated much research in the Southern States as to its causation and treatment. Voegtlin believes that the dietary of pellagrins is deficient in vitamines. It is known that pellagrins subsist on a dietary that is not rich in vitamines. The recent investigations made by Goldberger and other officers of the Public Health Service seem to bear out this assertion. The foodstuffs forming their principal alimentation consist of highly milled cereals, principally corn, and fat pork, in addition to carrots and turnips and similar vegetables. It is also believed that baking soda, which is used as a leavening for making cornbread, tends to further lower the vitamine content.

From the available data at hand, one may conclude that the prevalence of pellagra in the South is due to several factors: (*a*) the highly milled wheat and corn products which are undoubtedly deficient in vitamines; (*b*) the preparation of bread from both highly milled flour and corn meal by using baking soda for leavening, without buttermilk or tartaric acid, which permits the deleterious effect of the strong alkali to destroy the vitamine content of the food; (*c*) changes in the economic conditions of the population, and in food production and supply—all of which seem to exert an unfavorable influence on the dietary of the poorer people. The increased cost of living places beyond their reach the more expensive foods

—meat, eggs, milk, etc.—having a fairly high vitamine content, which are not so liberally used as heretofore, and a reduction in the amount of these important foods, therefore, reduces the vitamine content of the ration. During the past ten years, the cost of food has increased out of proportion to the increase in wages, and pellagra has likewise increased during this decade.

The reduction of the vitamine content of the diet of pellagrins is due (*a*) to the reduction, for economic reasons, of certain aliments in the dietary, of vitamine—rich foods, such as fresh milk, eggs and meats; (*b*) the introduction of highly milled cereals, and (*c*) to the use of baking soda as a leavening, which exerts a destructive action on the vitamine content of bread.

The fact that the above-mentioned influences, which have undoubtedly reduced the vitamine content of the diet, made themselves felt a relatively short time before the rapid increase in pellagra in the South, furnishes considerable evidence in favor of the vitamine-deficiency theory of pellagra.

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CHAPTER IX

THE CALORIC METHOD OF FEEDING

WINFIELD S. HALL, PH.D., M.D.

Every bill of fare should be based upon calorimetric experimentation; the practical trophodynamic consideration of the foodstuffs; due cognizance of the ailment of the patient, and no bill of fare should ever be a theoretical prescription culled from lists.

Food as a Source of Heat and Growth: Introductory; Unit and Method of Measurement; Heat by Combustion of Various Substances and Foods; Standard and Sample Dietaries; Caloric Values of Ingested Foods; Constructive and Fuel Foods; Caloric Requirement of Man; Calorific Value of Excretory Products; Physiological Food Value.

Calculation of Fuel Values of Food: Chemical Analyses of Foods; Method of Reckoning the Protein, Fat and Carbohydrate Rations for Diets of Definite Energy Values.

Factors Governing the Amount of Food Required: Amount of Heat Lost by Body; Weight of Body; Age; Sex; Kind of Work; Choice of Food; Intensity of Muscular Activity.

Regulation of Body Temperature: Physical Heat Regulation; Chemical Heat Regulation; The Surface Areas of the Skin in Heat Regulation; Regulation of Heat Loss; Production of Heat during Rest; Résumé.

FOOD AS A SOURCE OF HEAT AND GROWTH

Introductory.—Probably no single contribution to trophodynamics has been more fruitful in its consequence than the calories idea. It was no small achievement to put the body's need for physiological fuel upon a definite basis and to give a concrete significance to the trophodynamic factor in nutrition. Possibly in the remote past, Nature's scheme for feeding man did not contemplate the accurate measuring of his food, other than to provide him with healthy, normal instincts. At the present age, however, food requirements have become a matter of accurate estimation rather than animal intuition. Under-nutrition can be demonstrated by direct dieting investigations, the increased demands for food—fuel for

the working man, as well as the relative abundance of the ration for the infant at different stages of growth, need no longer remain veiled in the mystery of uncertainty.

The past two decades have witnessed the developments of scientific methods, rendered possible by really accurate investigations relative to the trophodynamics of foods. "They show," declares Prof. Armsby, "that the transformations of chemical energy into heat and work in the animal body take place according to the same general laws and with the same equivalencies as in our artificial motors and in lifeless matter generally. The great law of the conservation of energy rules in the animal mechanism, whether in man, carnivora or herbivora, just as in the engine. The body neither manufactures nor destroys energy. All that it gives out it gets from its food, and all that is supplied in its food is sooner or later recovered in some form. We are fully justified, therefore, in speaking of the food as body fuel, and in our studies of its utilization we may be confident that any food energy which does not reappear in the form of heat or work has not been lost, but has been stored up in the body as the chemical energy of meat, fat, etc., which may later serve to supply food-energy to the human body."

Atwater(1), Langworthy(2) and their coworkers have collected data and published a resumé of almost all the known metabolism-experiments of value in determining the trophology, trophodynamics and trophotherapy of foodstuffs. The results of their studies in metabolism exceed by far those of any other observers in any other country. The scope and importance of their experimental work, as stated by Atwater, the leading American authority on this science, is as follows:

The science of nutrition must be studied from the standpoints of the metabolism of matter and energy, if its fundamental laws are to be thoroughly learned. The ideal experiment for the determination of metabolic balance would include, (*a*) a respiration experiment, (*b*) a dietary study, and (*c*) a digestion experiment in which the thermal values of food and excreta are determined. It would also include a measurement, with a calorimeter or by other suitable means, of the heat produced in the organism. If work is also performed, it must also be measured. No experiment has yet been made which reaches this ideal. More often special problems connected with metabolism have been the subject of investigation, such as the following: The functions of the nutrients of food; the formation of fat from protein and from carbohydrates; the digestibility of foods of various kinds; the isodynamic values of nutrients; the fuel value (potential energy) of food; the influence on metabolism of various diseases, of alcohol, drugs, condiments, and the like, and of various forms of treatment, medical or otherwise, as for instance, hot water baths; the influence of prolonged hunger or thirst on metabolism; and the quantities of nutrients consumed and appropriate for people of different classes,

occupations, and conditions, and for animals of different kinds or animals fed for different economic purposes.

The quality and quantity of diet exert a far-reaching influence upon the development of the race, an influence which is readily observed in the physical well-being associated with an adequate supply of suitable food. The problems of dietetics are of great intricacy, for no definite food or combinations of foods, can be regarded as suitable for different people, or for the same individual under different circumstances. The application of experimental research in trophotherapy, as in other branches of science, has yielded some insight into the general principles which govern the nutrition of man.

One may well ask the question, then: "Why do physicians take so much care in measuring the exact dosage of drugs which are administered only occasionally, and give such little attention to measuring their food prescriptions which are to be followed daily?" A physician who instructs his patients to take "a little" strychnia or a "big dose" of calomel, etc., would be regarded as criminally negligent, yet, in prescribing diet, this is just the kind of advice that physicians usually give. It is rather paradoxical that a question which so intimately engages the attention of mankind, like food and drink, has been given so little attention by the medical profession. The study of the therapeutic indications of food is a question which will demand the attention of the physician of the future. He will find specific medication—theoretically speaking—in the so-called "specific values" of the articles of nutrition or aliments. It is no longer a question that certain diseases can be successfully treated by the administration of properly selected and prepared articles of diet which have a distinctively active or medicinal influence over certain pathologic conditions. In many instances a clear understanding of the proper kind and proper dosage of food is more important to the physician than any knowledge of the use of drugs. The appreciation of the physiological demands of the organism necessitates the recognition of both quantitative and qualitative needs. If we would be able to give our patients the proper advice, we must carefully study foodstuffs, their composition, their preparation, their digestibility and their *trophotherapeutic* effects, which is the science that deals with the treatment of disease with food. *Trophodynamics* deals with the science of the powers and effects of foods *Trophology* is the science of the nature and properties of materials that are used as food. Since our knowledge of the pathogenesis of a large number of diseases is imperfect, we are not in a position at the present time to lay down definite rules for the treatment and cure of disorders that are due to a

constitutional or nutritional nature, except in a very limited number of cases.

Unity and Method of Measurement.—The unit of measure to determine the fuel value of foods is the *calorie.*[1] It may be defined as that amount of heat required to raise the temperature of one kilogram of water to 1 degree Centigrade. To determine the fuel value of any food, that is, to calculate the amount of energy liberated by the burning of a given quantity of combustible material, we use the instrument called the *calorimeter.* Various forms of calorimeter have been devised, one of the best being the bomb calorimeter devised by Berthelot. This instrument and the method of its use have been fully described by Atwater and Snell(3). "In outline, it consists of a heavy steel bomb with a platinum or gold-plated copper lining and a cover held tightly in place by means of a strong screw collar. A weighed amount of sample is placed in a capsule within the bomb, which is then charged with oxygen to a pressure of at least 20 atmospheres (300 pounds or more to the square inch), closed, and immersed in a weighed amount of water. The water is constantly stirred and its temperatnre taken at intervals of one minute by means of a differential thermometer capable of being read to one thousandth of a degree. After the rate at which the temperature of the water rises or falls has been determined, the sample is ignited by means of an electric fuse, and, on account of the large amount of oxygen present, undergoes rapid and complete combustion. The heat liberated is communicated to the water in which the bomb is immersed and the resulting rise in temperature is accurately determined. The thermometer readings are also continued through an "after period," in order that the "radiation correction" may be calculated and the observed rise of temperature corrected accordingly. This corrected rise, multiplied by the total heat capacity of the apparatus, and the water in which it is immersed, shows the total heat liberated in the bomb. From this must be deducted the heat arising from accessory combustions (the oxidation of the iron wire used as a fuse, etc.) to obtain the number of calories arising from the combustion of the sample."

Through the aid of the calorimeter we are able to determine not only the heat given off by the combustion of any oxidizable material such as carbon, fat, starch, albumin, alcohol, sugar, etc., but also the amount radiated or conducted away from any body, for example, the living animal. Since the body gets its energy from the oxidation of the same

1 When the term "calorie" is used in this work it is intended to refer to the greater calorie, *i.e.*, the amount of heat necessary to raise the temperature of one kilogram of water one degree Centigrade. This is practically the same as the amount of heat required to warm four pounds of water one degree Fahrenheit.

kind of compounds which exist in foods, that is, essentially from carbohydrates, fats, proteins, and their cleavage products, if we know the kinds and amounts of foodstuffs eaten and the extent to which they are oxidized in the body, we can estimate in calories the amounts of energy liberated.

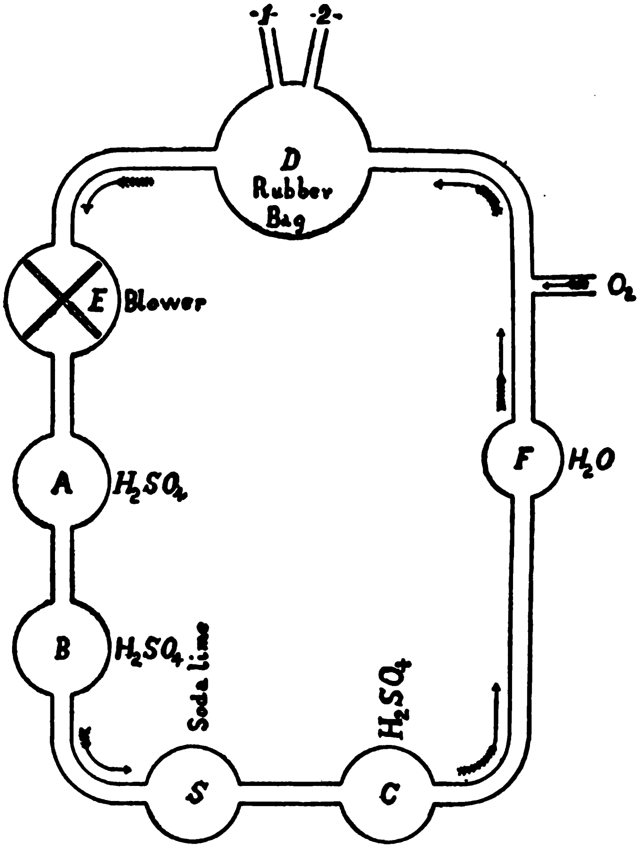

FIG. 4.—DIAGRAM OF THE BENEDICT "UNIVERSAL" OR "UNIT" APPARATUS FOR MEASURING ABSORPTION OF OXYGEN AND OUTPUT OF CARBON DIOXID.

Heat of Combustion of Various Substances and Foods.—The average results of calorimetric combustion show for:

Carbohydrates	4.1	calories	per	gram
Fats	9.45	"	"	"
Protein	5.65	"	"	"

The heat of combustion of various substances as well as the relation between their elementary composition will be made clearer by the study of the table on page 248 from Sherman (4), which includes the number of typical compounds found in food or formed in the body:

HEAT OF COMBUSTION AND APPROXIMATE ELEMENTARY COMPOSITION OF TYPICAL COMPOUNDS

	Heat of Combustion, Calories per gram	Carbon, per cent	Hydrogen, per cent	Oxygen, per cent	Nitrogen, per cent	Sulphur, per cent	Phosphorus, per cent
Glucose	3.75	40.0	6.7	53.3			
Sucrose	3.96	42.1	6.4	51.5			
Starch / Glycogen	4.22	44.4	6.2	49.4			
Body fat	9.60	76.5	12.0	11.5			
Butter fat	9.30	75.0	11.7	13.3			
Edestin	5.64	51.4	7.0	22.1	18.6	0.9	
Legumin	5.62	51.7	7.0	22.9	18.0	0.4	
Gliadin	5.74	52.7	6.9	21.7	17.7	1.0	
Casein	5.85	53.1	7.0	22.5	15.8	0.8	0.8
Albumin	5.80	52.5	7.0	23.0	16.0	1.5	
Gelatin	5.30	50.0	6.6	24.8	18.0	0.6	
Creatin	4.58	42.5	6.2	14.1	37.2		
Urea	2.53	20.0	6.7	26.7	46.6		

The following table from Hall(5) graphically expresses the calories represented in different foods and other substances involved in the processes of nutrition:

TABLE SHOWING CALORIES PER GRAM OF DRY SUBSTANCE

1 Gram dry substance	Heat of combustion in calories
Starch or glycogen	4.182
Cane sugar	4.176
Dextrose	3.940
Lactose	4.162
Carbohydrates, average; absorbed and available	4.0
Fat (one form)	9.686
Fat (another form)	9.423
Butter	7.264
Fats, average; 9.4; absorbed and available	9.0
Egg, white	4.896
Egg, yolk	6.460
Egg average, white and yolk	5.678
Lean beef	5.656
Casein	5.849
Vegetable proteins	5.500
Proteins, average	5.650
Protein, unavailable energy (unabsorbed or unoxidized)	1.650
Proteins, available energy for use in body	4.0
Carbon, per gram	8.080
Hydrogen, per gram	34.662

Standard and Sample Dietaries.—We have just studied "heat of combustion and approximate elementary composition of typical compounds," together with the "calories represented in different foods involved in the process of nutrition," and, before entering upon a consideration of the theoretical requirements of individuals, some standard dietaries and a few examples of diets consumed by people of different classes such as represented in the table [1] below should guide us in arranging a diet for groups of people in various circumstances and following varied occupations:

STANDARD DIETARIES

Standard dietaries and others	Protein, Grams	Fat, Grams	Carbohydrates, Grams	Energy, Grams
Standard Diet: Ranke's	100	100	240	2,310
Moleschott's	130	84	404	2,970
Pettenkofer and Voit's	137	117	352	3,113
Cornet's	120	60	500	3,007
Playfair's	119	51	530	3,025
Parke's	127	99	397	3,172
The diet of Harvard University boat crew	162	175	449	4,130
Harvard Freshman boat crew	153	223	468	4,620
Yale University boat crew	145	170	375	3,705
Harvard University boat crew (2d observation)	160	170	448	4,075
Harvard Freshmen boat crew (2d observation)	135	152	416	3,675
Yale University boat crew (2d observation)	171	171	434	4,070
Captain of Harvard crew	135	181	487	4,315
Average of above diets	135	177	440	4,085
Football team: Connecticut	181	292	557	5,470
Football team: California	270	416	710	7,885
Professional athlete	244	151	502	4,460
Athletes at Helsingfors	217	259	431	5,070
	182	204	392	4,254
Brickmakers in Connecticut	222	265	758	6,484
Mechanics in United States	154	227	626	5,275
Lumbermen in Maine	206	387	963	8,140
United States Army ration	164	98	600	4,061
United States Navy ration	143	184	520	5,000
English Royal Engineers in active work	144	83	631	3,950
English soldiers on special duty	190	58	510	3,426
	145	150	450	3,503
European soldiers in Batavia	136	79	497	3,000
Mechanics in Germany	139	113	677	4,395
Farm laborers in Austria	159	62	977	5,235
Factory operatives in Russia	132	80	584	3,680
Mechanics in Sweden	189	110	714	4,725

[1] From Bull. 45, U. S. Dept. Agric., and various other sources.

Caloric Values of Ingested Foods.—In the process of digestion and absorption, the combustion of fats and carbohydrates yields products identical with those in the calorimeter, and gives out an equivalent amount of heat. This does not hold true with protein, however, which in the bomb turns to carbon dioxid, water and nitrogen, but in the body yields no free nitrogen, for here urea and other organic nitrogen compounds are excreted as end products of protein digestion (*see* Volume I, Chapter VII, Physiology and Absorption). From this data it will be seen that these organic nitrogenous end products which are combustible result from a more incomplete oxidation of protein in the organism than that occurring in the bomb. The estimation of the loss of potential energy is based on the theory that the total quantity of nitrogen excreted from the body as urea would amount to about 0.9 calories per gram of protein. However, this problem is not as simple as would seem at first sight, for, owing to the excretion of other matter (creatinin, uric acid, and the like) of higher combustion, the real loss from end products is increased to the average of about 1.3 calories per gram of protein disintegrated in the organism. Therefore, it is correctly estimated that when the body burns material which it has previously absorbed it obtains:

From carbohydrates	4.1	calories per gram
From fats	9.35	" " "
From protein (5.65—1.30).	4.35	" " "

An allowance must be made, however, when calculating the fuel value of food to allow for the fact that a part of each of the materials is lost in digestion, so that the approximate values of a mixed diet are:

Carbohydrates ...	2 per cent lost,	98 per cent absorbed
Fats	5 per cent lost,	95 per cent absorbed
Protein	8 per cent lost,	92 per cent absorbed

When allowance is made for the above losses, biological chemists have approximated the physiological fuel value of food constituents consumed to be as follows:

Carbohydrates ..	(4.1 × 98 per cent)	yield 4. calories per gram
Fats	(9.45 × 95 per cent)	yield 9. calories per gram
Protein	(4.35 × 92 per cent)	yield 4. calories per gram

Rubner's calculation shows the energy values of foodstuffs to be as follows:

Carbohydrates	yield	4.1	calories	per	gram
Fats	"	9.3	"	"	"
Protein	"	4.1	"	"	"

Rubner's estimate was derived from experiments with dogs fed on meat, starch, sugar, etc., and made no calculation for the loss in digestion as has been found by other competent observers to occur with men living on an ordinary well-balanced ration.

Food ingested represents potential chemical energy which is the source of all bodily energy. In order to arrive at a correct determination of the potential energy in food consumed, it is necessary to know how much food is consumed and the potential energy of the various foodstuffs. By referring to page 258 will be found a table which graphically expresses the caloric value of different foods involved in the process of nutrition. The reader is also requested to consult The Analysis and Fuel Value of Foods, Volume I, Chapter XIX, which contains a list of all known American foods and graphically presents the analysis of foods, showing the percentage of protein, fat, carbohydrate and mineral salts with the caloric value per pound and per portion.

Constructive and Fuel Foods.—We have previously pointed out in this chapter, the methods for calculating the fuel value or potential energy of foods. It has been determined by means of calorimetric experiments that the amount of heat given off from a known weight of food substance is fairly constant and is called the *heat value,* or *heat of combustion,* which is expressed in *calories.* The consideration of a large number of estimations of the heat value produced in the calorimeter and of the digestibility of foods led Rubner(6) to fix their value approximately, as graphically pointed out in table on this page. These figures are accepted by the majority of observers as being approximately correct, and so have passed into common use. The experiments of Rubner, Atwater and other investigators seem to show that the various foods may replace each other in exact ratio to energy derived from them which we have already discussed (Volume II, Chapter V, Various Factors Bearing on Diet, Digestion and Assimilation). Thus 100 grams of fat are isodynamic with 225 of syntonin, 243 grams of dried muscle, 232 grams of starch, 234 grams of cane sugar and 256 grams of dextrose. In other words, 227 grams of carbohydrates or protein are equal in isodynamic value with 100 grams of fat, because they yield 930 calories on combustion in the body.

As shown in a previous chapter (Volume II, Chapter VII), a certain amount of protein is necessary to sustain life. It is not sufficient to say that a food to be able to maintain life and strength can furnish a given number of calories, since any number of calories can be obtained from fat, but fat will not maintain life nor promote growth of cells. Alimentation must be estimated in terms of protein required and of calories required. A large proportion of the latter can be obtained from variable amounts of fats and carbohydrates, but such an alimentation would not build the body, though it would furnish the necessary fuel for body activities.

Let us emphasize at this point the two clearly differentiated needs of the body: (*a*) for constructive material, and (*b*) material for fuel. The constructive foods are: proteins, salts and water. The fuel foods are: sugar, starch and fat. Note that the fuels are composed of carbon, hydrogen and oxygen. They are, chemically, *the carbonaceous foods*, which oxidize to CO_2 and H_2O. The value of these fuel foods to the body is based wholly upon their fuel value, which is measured by the number of calories of heat which they liberate on oxidation.

On the other hand, the value of the constructive foods cannot at all be measured by the number of calories which they represent. Salts, for example, are of inestimable value for body building, yet they have no caloric value—no fuel value. Water and the salts are just as truly foods as are the starches, sugars and fats; but they are *constructive foods* of no fuel value. Similarly, the proteins bring C, H, N, S, P and Fe, to the body in combinations readily digested, absorbed and assimilated into living active tissues. These elements and combinations are absolutely essential to growth and repair. Their constructive value—their food value—is very great. The fuel value of proteins (5.65 calories per gram) is partly available eventually for fuel purposes when taken in minimal quantities, and immediately available to the extent of 4 calories per gram when taken in excess of the requirements for construction. This available fuel value is its fuel value, not its *food value.* Fuel values are measured in calories and may be estimated in cents per calorie. Constructive food values can no more be estimated in money units than can the value of a living, functioning nerve or muscle cell be estimated in dollars and cents.

Caloric Requirement of Man.—The caloric requirement of an individual depends somewhat upon his weight and the amount of energy expended. As a result of much research and investigation, in order to establish a working standard, the weight fixed upon by various investigators has been

approximately 150 pounds. The caloric requirement for a man of this weight leading a sedentary life can be determined by the following four methods, as determined by Sherman(4):

(*a*) By observing the amount of food ingested by many men in different countries and under varying conditions.

(*b*) By determining the approximate amount of oxygen consumed.

(*c*) By determining the equilibrium or balance of intake and output.

(*d*) By direct calculation of the heat given off by the body.

These various methods give approximately the same findings: a man at rest requires 2,000 calories, and one leading a sedentary life requires 2,300 calories.

The protein requirement for a man at work cannot be determined so accurately. It has been attempted by various observers with the following results:

Voit in Germany fixed upon 118 grams of protein as the standard.

Playfair in England fixed upon 119 grams of protein as the standard.

Gautier in France fixed 107 grams as the standard.

Atwater in this country fixed 100 grams of protein as the standard for a man of sedentary habits.

Atwater also fixed 125 grams for a man at moderate work, 150 grams for a man at hard work, 90 grams for one completely at rest.

Chittenden decided upon 60 grams as the standard. His objection to the high protein ration, given by other workers in this field of research, is based, he says, upon evidence of self-indulgence and not upon the needs of an individual or upon the most profitable use of food. We give below the results of his experiments. For a man of average weight (154 pounds), it is necessary to provide for the requisite quantity of food, 60 grams of protein and a total caloric value of 2,800 calories. The following is a sample dietary suggested by Chittenden(7), showing the protein in grams and the caloric value of each article:

THE CHITTENDEN LOW PROTEIN DIETARY

Breakfast:	Protein, grams		Calories	
1 shredded wheat biscuit (30 gm.)	3.15		106	
1 teacup of cream (120 gm.)	3.12		206	
1 German water roll (57 gm.)	5.07		165	
2 one-inch cubes of butter (38 gm.)	0.38		284	
¾ cup of coffee (100 gm.) with	0.26			
¼ cup of cream (30 gm.)	0.78		51	
1 lump of sugar (10 gm.)	...		38	
	——	12.76	—	850

THE CHITTENDEN LOW PROTEIN DIETARY—*Continued*

Lunch:	Protein, grams		Calories	
1 teacup home-made chicken soup (144 gm.).....	5.25		60	
1 Parker House roll (38 gm.)..................	3.38		110	
2 one-inch cubes of butter (39 gm.)............	0.38		284	
1 slice lean bacon (10 gm.)....................	2.14		65	
1 small baked potato (2 oz.–60 gm.)............	1.53		55	
1 rice croquette (90 gm.)......................	3.42		150	
2 ounces maple sirup (60 gm.)..................	....		166	
1 cup tea with 1 slice lemon...................	....		..	
1 lump sugar (10 gm.)..........................	....		38	
	——	16.10	——	928
Dinner:				
1 teacup cream of corn soup (130 gm.)..........	3.25		72	
1 Parker House roll (38 gm.)...................	3.38		110	
1 one-inch cube of butter (19 gm.).............	0.19		142	
1 small lamb chop broiled, lean meat (30 gm.)....	8.51		92	
1 teacup of mashed potato (167 gm.)............	3.34		175	
Apple-celery lettuce salad with mayonnaise dressing (50 gm.)..............................	0.62		75	
1 Boston cracker split, 2 in. in diameter (12 gm.).	1.32		47	
½-inch cube American cheese (12 gm.)..........	3.35		50	
½ teacup of bread pudding (85 gm.)............	5.25		150	
1 demi-tasse coffee............................	....		...	
1 lump sugar (10 gm.)..........................	....		38	
	——	29.21	——	951
Total grams of protein...........................		58.07		
Total calories...................................				2729

The total amount of protein in grams and the total calories in this dietary, as stated above, may be taken as approximately correct. It will be seen that he has reduced the protein to as low a point as is compatible with good health, mental and physical strength, but has allowed sufficient carbonaceous food to produce the requisite calories for normal energy. We have stated heretofore, and will reiterate again, that more protein is ordinarily consumed than is needed and often more than is good for one.

Calorific Value of Excretory Products.—All non-nitrogenous foodstuffs which have undergone complete digestion and assimilation yield in our bodies the same amount of heat as in the calorimeter, the final products being the same. The nitrogenous foodstuffs are not so completely metabolized; the oxidation of proteins in the body is not complete. We learned, when studying the Physiology of Digestion, that the protein molecule is made up of some twenty or more amino-acids. We also found that the protein molecule is split into a nitrogen-moiety and a carbon-moiety(8). The carbon-moiety is as completely oxidized in the body as in the calorimeter experiments. The nitrogen-moiety is not reduced in the animal body to ammonia and water—the ultimate products of nitrogenous decomposition—but it is excreted as an organic compound, which

in man is chiefly urea, and a smaller proportion of quaternary substances (usually referred to as "meat bases") which have a calorie value but no food value. In order to arrive at the definite calorific value of the excretory products, they must be subtracted from the fuel value of nitrogenous foodstuffs as ascertained by calorimetric experimentation. The balance represents only the actual energy yielded to the body and is known as the *"physiological heat"* value. It may be noted in passing that the unavailable energy of the proteins is that represented by the urea, urates, nitrates, sulphates and other more or less complex substances excreted in the urine which are subject to further combustion, so that the animal body is able to extract from proteins only about four calories, while the calorimeter experiments in complete combustion is able to extract 5.65 calories.

It may be safely stated as a general working rule, that each gram of protein consumed results in the excretion of about one-third of a gram of urea.

The factors of Rubner, as previously mentioned, are generally agreed upon as being approximately correct, but, in order to ascertain the physiological available energy, the food should be burnt in a bomb calorimeter already described, and the figure obtained will be the gross heat value. From this, as we have previously mentioned, must be subtracted the heat yielded by the urine and feces by combustion, and the net will show the physiological availability of the energy. In his physiological researches, Rubner(6) made many such experiments, and the following is summed up from his results, to which Tibbles(9) refers:

RUBNER'S TABLE SHOWING LOSSES AND AVAILABLE ENERGY

Food	Heat Lost, Per Cent			Availability of Energy, Per cent
	In Urine	In Feces	Total	
Mixed diet: Poor in fat	4.70	6.00	10.70	89.3
Rich in fat	3.87	5.73	9.60	90.4
Meat diet	16.30	6.90	23.20	76.4
Cow's milk	5.13	5.07	10.20	89.4
Graham bread	2.40	15.50	17.90	82.1
Rye bread	2.20	24.30	26.50	73.5
Potatoes	2.00	5.60	7.60	92.4

Physiological Food Value.—The value of a fuel food to the body is finally measured by the number of calories which it can yield when oxidized in the tissues—the physiological food value. But this value depends upon digestibility and absorbability. It was formerly considered

that the measure of digestibility of any foodstuff depended upon the length of time it remained in the stomach and freedom from discomfort during the process of digestion. In normal individuals the process of digestion is unaccompanied by any feelings save that of satisfaction and well being. It is only under abnormal conditions that the presence of food in the stomach or alimentary canal gives rise to any other sensation. Beaumont(10), in a long series of experiments on Alexis St. Martin, who suffered from a gastric fistula, was able to determine exactly the length of time the food remained in the stomach. For many years his experiments were accepted as authoritative, but the science of nutrition has shown many errors in his reasoning and conclusions.

Physiologists in recent years have conducted experiments with the object of ascertaining the period of time various foods remain in the stomach(11). Penzoldt, in working out this question, made observations on the gastric digestion in healthy men.[1] He allowed his subjects to have a stated amount of certain foodstuffs, the exact amount and consistence of which he took careful note. He allowed this to remain in the stomach for a definite time and removed the contents with a stomach tube, and he found that the time it remained in the stomach had a marked influence upon it. Physiologists have definitely determined the fact that fluids pass out of the stomach more rapidly than solids. For instance, six to eight ounces of water or beverages pass out of the stomach during the course of 30 minutes. It was found that hot drinks did not pass out of the stomach any quicker than cold ones. Solid food substances in solution or suspension were somewhat delayed in leaving the stomach, thus it took two hours for eight ounces of milk to pass through the stomach. It is a well-known fact that the length of time food remains in the stomach is not a definite criterion of the ease or difficulty of its digestion. On the other hand, it would be an error to consider as "indigestible" those foods which remain in the stomach a longer time than others or to suggest that they should be avoided by healthy people.

According to Tibbles(8):

> The test of time occupied by its passage through the stomach refers only to the "apparent digestibility," while the test of "actual digestibility" is the amount absorbed. It has been truly said that "We live not upon what we eat, but upon what we digest." The term "digestibility," therefore, refers to the entire process of digestion, and not merely to that which occurs in the stomach. In this sense a "digestible food" is one of which the largest possible percentage is absorbed, and an "indigestible food" is one of which a considerable portion passes out of the system in the feces without being disintegrated and absorbed.

[1] *See* Volume III, Chapter I, for Penzoldt's observations.

CALCULATION OF FUEL VALUES OF FOOD

Chemical Analyses of Foods.—To calculate the fuel values of food it is necessary to have before one tables showing the chemical analysis of the food in question. Taking from the tables the component parts of the aliment to be used, and multiplying by the factors representing the number of calories per gram of carbohydrates, fats or proteins as the case may be, one can quickly determine the calories per 100 gram or the calories per pound in any given article of food. For assistance on this point the reader is referred to an abbreviated table given on the following page, containing the estimate of protein, fats, carbohydrates and caloric value for portions ordinarily served. For a more extensive table, see Volume I, Chapter XIX, where an accurate analysis of protein, fats, carbohydrates, mineral matter and caloric value per pound and per portion is given for the different American foods. A study of these tables will afford a basis for calculating the requisite number of calories contained in different foods for a well-balanced ration.

From the following table compiled from the more extensive work by Locke(12) it will be easy to estimate the percentage of ternary food elements contained in the common foodstuffs, together with the caloric value given for individual portions ordinarily served:

COMPARATIVE EQUIVALENTS IN METRIC, AVOIRDUPOIS AND APOTHECARIES' WEIGHTS AND MEASURES[1]

Weights						Metric Weights and Measures	Measures		
Grains	Apothecaries' oz.	gr.	Avoirdupois lb.	oz.	gm.	gm. or c.c.	Fluid oz.	minims	Fluid ounces and fractions
15432.4	32	72.4	2	3	119.9	1000	33	390.06	33.814
7000.0	14	280.0	1	..	....	453.592	15	162.1	15.338
1543.2	3	103.2	..	3	230.7	100	3	183.1	3.382
480.0	1	....	..	1	42.5	31.1035	1	24.8	1.052
456.392	..	....	..	1	18.89	29.5737	1	.....	1
437.5	..	.....	..	1	....	28.350	..	460.1308	0.959
15.4324	..	....	..	..	.....	1	..	16.23	0.0338
1	..	....	..	..	.....	0.06479	..	1.0517	0.0022
0.9508	..	....	..	..	.....	0.06161	..	1	0.0021

[1] From the United States Pharmacopeia.

VALUES OF THE ORDINARY FOODS PREPARED TO SERVE

Foodstuffs	Quantity	Weight (Gms.)	Protein (Gms.)	Fats (Gms.)	Carbohydrates	Total Calories
Beef juice	4 ounces	120	5.88	0.72	....	31
Corned beef hash	2 heap. tblspoon.	100	6.00	1.90	9.40	81
Roast beef	1 slice	100	22.30	28.60	....	357
Steak, tenderloin beef	1 "	100	23.50	20.40	....	286
Sweetbreads	2	80	32.00	0.45	....	135
Creamed chicken on toast	2 heap. tblspoon.	125	16.26	12.62	21.76	273
Roast chicken	1 slice	100	32.10	4.40	2.10	181
Lamb chop with bone	1 chop	100	21.70	29.90	....	367
Roast lamb	1 slice	75	14.78	9.53	....	150
Boiled mutton, lean	1 "	75	23.18	3.38	....	126
Mutton chop, lean	1 chop	100	22.60	4.50	....	135
Mutton, roast leg	1 slice	75	18.75	16.95	....	234
Ham, smoked, boiled, as purchased	1 "	33	7.29	6.80	....	93
Ham, smoked, fried	1 "	35	7.77	11.62	....	140
Sausage, uncooked	1 sausage	35	4.55	15.47	0.39	164
Roast turkey	1 slice	100	27.80	18.40	....	285
Veal cutlet	1 cutlet	80	22.82	1.14	....	104
Veal roast	1 slice	75	21.33	1.00	....	97
Bluefish	Average helping	100	25.90	4.50	....	148
Codfish	" "	100	21.68	0.27	1.58	98
Halibut	" "	100	20.35	4.04	....	121
Mackerel	" "	70	11.73	4.48	2.62	104
Salmon	" "	100	19.65	10.21	5.36	198
Sardines, canned	1 fish	10	2.30	1.97	....	28
Trout, brook	Average helping	50	10.57	1.17	.62	57
Clams, long	6 clams	150	12.90	1.5	3.00	79
Clams, round	6 "	100	6.50	0.4	4.20	47
Crabs, hard shelled, as purchased	1 crab	245	19.36	2.21	1.47	106
Lobster		105	17.22	1.89	.42	90
Oysters	6 oysters	85	5.27	1.02	3.15	44
Oyster stew	4 ounces	124	6.07	11.06	10.53	171
Scalloped oysters	6 large oysters	138	8.06	18.58	11.98	255
Scallops, fried	3 heap. tblspoon.	110	28.20	1.75	6.02	158
Bean soup, home-made	1 teacup	120	3.84	1.68	11.28	78
Chicken soup, home-made	1 "	120	12.60	0.96	2.88	72
Chicken gumbo soup, canned	1 "	120	4.56	1.08	5.64	52
Clam chowder, home-made	1 "	120	2.16	.96	8.04	51
Consommé, canned	1 "	120	3.00	....	0.48	14
Asparagus, cream soup	1 "	125	3.44	8.62	4.87	114
Celery cream soup	1 "	125	3.00	8.94	5.01	116
Corn cream soup	1 "	125	3.75	8.70	10.66	140
Pea cream soup	1 "	125	6.29	8.46	14.07	162
Tomato cream soup	1 "	125	2.99	9.40	6.36	126
Mock turtle, canned	1 "	120	6.24	1.08	3.36	50
Oxtail soup, canned	1 "	120	4.80	1.56	5.16	55

VALUES OF THE ORDINARY FOODS PREPARED TO SERVE—*Continued*

Foodstuffs	Quantity	Weight (Gms.)	Protein (Gms.)	Fats (Gms.)	Carbohydrates	Total Calories
Vegetable soup, canned.	1 teacup	120	3.48	....	0.6	17
Butter	1 ball	15	0.15	12.75	....	119
Average cream	1 tblspoon.	20	0.74	5.14	0.71	54
Thick cream	1 "	20	0.31	11.22	.46	108
American cheese, pale	1 cubic inch	20	5.70	7.18	0.06	91
Camembert cheese	1 heap. tblspoon.	20	4.20	4.34	....	58
Fromage de brie	1 cubic inch	20	3.18	4.20	0.28	53
Full cream cheese	1 " "	20	5.18	6.74	0.48	86
Neufchâtel cheese	1 " "	20	3.74	5.48	.30	68
Roquefort cheese	1 " "	20	4.52	5.90	0.36	75
Swiss cheese	1 slice	20	5.52	6.98	0.26	89
Kumiss	1 wineglass	130	3.64	2.73	7.02	69
Buttermilk	1 glass	218	6.54	1.09	10.46	80
Whole milk	1 "	220	7.26	8.80	11.00	157
Whey	1 "	203	2.03	0.61	10.15	56
Hen's eggs, boiled	1 egg	50	6.60	6.00	....	83
Omelette, egg	½ omelette	75	9.80	14.01	1.55	177
Ingredients: 3 tblspoon. milk, 3 eggs, 1 heap. teaspoon butter						
Asparagus, canned		125	1.88	0.13	3.50	23
Baked beans, home-made	3 heap. tblspoon.	150	10.83	12.76	32.84	298
Butter beans	4 " "	180	63.78	0.24	11.60	65
Lima beans	2 " "	80	6.40	0.54	23.60	128
String beans	2 " "	60	0.48	0.66	1.14	13
Beets	2 " "	70	1.61	0.07	5.18	29
Cabbage	3 " "	100	0.60	0.10	0.40	5
Carrots	3 " "	100	0.53	0.17	3.39	18
Cauliflower	2 " "	120	1.08	0.12	0.48	8
Celery, uncooked	3 small stalks	55	0.50	0.05	1.43	8
Corn, canned	2 heap. tblspoon.	100	2.80	1.20	19.00	101
Corn, green	1 ear	100	3.07	1.10	18.78	100
Cucumber, uncooked	8 thin slices	50	0.40	0.10	1.55	9
Mushrooms, broiled	2 large, on toast	57	3.52	8.94	12.85	150
Onions	1	100	1.20	1.80	4.90	42
Peas, green	3 heap. tblspoon.	92	6.16	3.13	13.43	110
Potatoes, sweet, boiled	Average size	100	3.00	2.10	42.1	204
Baked potatoes	Medium "	130	3.77	0.20	32.07	149
Boiled potatoes	" "	150	3.75	0.15	31.35	145
Mashed and creamed potatoes	2 heap. tblspoon.	100	2.60	3.00	17.80	112
Squash	2 " "	100	1.36	0.82	13.60	69
Spinach	2 " "	100	2.10	4.10	2.60	57
Tomatoes, canned	2 " "	70	0.84	0.14	2.80	16
Tomatoes, uncooked	Medium size	200	2.40	0.40	8.00	46
Turnips	2 heap. tblspoon.	140	0.45	0.08	0.91	6
Apple	Average size	150	0.45	0.45	16.22	72
Banana	" "	194	1.55	0.78	27.74	127
Blackberries	3 heap. tblspoon.	100	1.30	1.00	10.90	59
Cantaloupe	½ melon	465	1.40	....	21.39	93

VALUES OF THE ORDINARY FOODS PREPARED TO SERVE—*Continued*

Foodstuffs	Quantity	Weight (Gms.)	Protein (Gms.)	Fats (Gms.)	Carbohydrates	Total Calories
Cherries	About ½ pound	100	0.90	0.80	15.90	76
Currants	4 heap. tblspoon.	100	1.50	....	12.80	59
Grapefruit	½ large	300	2.37	0.60	30.27	139
Grapes	1 bunch	150	1.50	1.80	21.60	112
Gooseberries	4 heap. tblspoon.	90	0.90	....	11.79	52
Huckleberries	4 " "	100	0.60	0.60	16.60	76
Lemon	Average size	130	.91	.65	7.67	41
Orange	" "	250	1.50	0.25	21.25	96
Peach	" "	128	0.64	0.13	9.86	44
Pear	" "	156	0.78	0.62	19.81	90
Pineapple, edible portion	2 slices	100	0.40	0.30	9.70	44
Plum	Average size	35	0.32	....	6.69	29
Raspberries	3 heap. tblspoon.	82	0.82	....	10.33	46
Strawberries	4 " "	100	1.00	0.60	7.40	40
Watermelon	Large slice	300	.60	0.30	8.10	39
Apricots, dried	10 large	80	3.76	0.80	50.00	228
Dates	10 "	83	1.58	2.08	58.60	266
Figs	10 "	117	8.38	0.58	59.28	633
Prunes	10 very large	200	3.60	....	124.40	525
Raisins	10 " "	25	0.57	0.75	17.13	80
Apple, baked	1 large	120	0.61	0.58	29.30	128
Apple, sauce	3 heap. tblspoon.	125	0.25	1.00	46.50	201
Cranberries, stewed	2 " "	100	0.27	0.41	36.00	153
Currant jelly	1 " "	35	0.36	....	27.16	113
Marmalade, orange	1 " "	30	0.18	0.03	25.35	105
Rhubarb, stewed	2 " "	90	0.40	0.47	32.40	139
Rye bread	1 slice	39	3.51	.23	20.74	102
Graham bread	1 "	37	3.29	0.67	19.28	99
Biscuits, home-made	1 biscuit	35	3.05	0.91	19.36	100
Biscuits, soda	1 "	38	3.53	5.21	19.99	145
Rolls, French	1 roll	39	3.32	0.98	21.72	112
Whole wheat	1 slice	42	4.07	0.38	20.87	106
Zwieback	1 "	15	1.47	1.49	11.03	65
Boston cracker (split)	1 cracker	10	1.10	0.85	7.11	42
Graham cracker	1 "	8	0.80	0.75	5.9	34
Oyster cracker	10 crackers	11	1.24	1.16	7.76	48
Pretzels	1 pretzel	6	0.58	0.23	4.37	22
Educators, soda cracker	1 cracker	3	0.97	....	1.39	10
Uneeda biscuits	1 "	6	0.59	0.55	4.38	25
Chicken sandwiches	1 sandwich	70	8.61	3.78	22.47	163
Egg sandwich	1 "	100	9.60	12.70	34.50	299
Ham sandwich	1 "	70	7.28	10.07	26.55	233
Cream toast *Ingredients:* 2 slices toast; 5 tblspoon. cream sauce.	2 slices	136	9.03	14.60	37.15	325
Grapenuts	5 heap. tblspoon.	65	7.78	0.40	51.51	247
Cornmeal mush *Ingredients:* 2 tablespoons white corn meal; 2 cups milk.	4 " "	115	3.85	4.11	9.52	93

VALUES OF THE ORDINARY FOODS PREPARED TO SERVE—*Continued*

Foodstuffs	Quantity	Weight (Gms.)	Protein (Gms.)	Fats (Gms.)	Carbohydrates	Total Calories
Hominy, boiled	2 heap. tblspoon.	100	2.20	0.20	17.80	84
Indian meal mush	3 " "	115	2.10	1.18	18.50	96
Macaroni, boiled	2 " "	100	3.00	1.50	15.80	91
Macaroni, baked with cheese	2 " "	140	19.06	20.46	43.44	447
Oatmeal, boiled	2 " "	100	2.80	0.50	11.50	63
Puffed rice	5 " "	14	0.87	0.08	12.00	54
Rice, boiled	1 " "	100	2.80	0.10	24.40	112
Shredded wheat biscuit	1 biscuit	29	3.05	0.41	22.59	109
Spaghetti, baked with tomato	3 heap. tblspoon.	145	4.52	2.81	25.76	150
Apple pie	⅙ pie	126	3.91	12.35	53.93	352
Custard pie	⅙ "	133	5.59	8.38	34.71	243
Lemon pie	⅙ "	110	3.96	11.11	41.14	288
Mince pie	⅙ "	113	6.55	13.90	43.05	333
Squash pie	⅙ "	133	5.85	11.17	28.86	246
Bread pudding. *Ingredients:* 1 cup bread crumbs; 1 cup milk; 1 egg; ½ cup sugar; ¼ cup raisins	2 heap. tblspoon.	105	5.52	4.79	38.48	225
Baked custard. *Ingredients:* 2 cups milk; 2 eggs; ¼ sugar.	2 " "	134	7.31	7.42	20.50	183
Soft custard. *Ingredients:* Yolk 1 egg; ½ cup milk; 1 heap. tblspoon. sugar.	4 tblspoon.	60	4.39	6.84	12.12	131
Snow pudding. *Ingredients:* ¾ cup water; 1 heap. teaspoon gelatin; 2 h. tblspoon. sugar; 1 teaspoon lemon juice lemon rind; white 1 egg.	2 heap. tblspoon.	80	4.52	0.03	11.73	67
Tapioca pudding. *Ingredients:* 2 cups milk; 1 egg, 3 tablespoons tapioca; 2 tablespoons sugar.	3 " "	110	5.85	6.12	22.25	172
Tapioca and apples. *Ingredients:* 9 small apples; 1 cup sugar: ⅔ cup tapioca; 2 cups water.	2 " "	100	0.21	0.22	28.58	120

VALUES OF THE ORDINARY FOODS PREPARED TO SERVE—*Continued*

FOODSTUFFS	Quantity	Weight (Gms.)	Protein (Gms.)	Fats (Gms.)	Carbohydrates	Total Calories
Blancmange............ *Ingredients:* 1 heap. tblspoon. cornstarch; 1 heap. tblspoon. sugar; 1 egg; 1 cup milk; 1 tblspoon. sherry	2 heap. tblspoon.	90	4.76	4.91	16.83	134
Doughnuts............	1 doughnut	37	2.48	7.77	19.65	163
Egg soufflé............ *Ingredients:* 2 eggs; ½ cup sugar; 1 tablespoon lemon juice	½ soufflé	50	5.22	4.09	38.09	216
Ice cream............. *Ingredients:* 3 cups milk; 1 cup cream; 3 eggs; ⅔ cup sugar; vanilla	2 heap. tblspoon.	100	5.21	10.16	17.73	189
Ladyfingers............	1	20	1.76	1.00	14.12	74
Macaroons............	1	10	0.65	1.52	6.52	44
Orange ice............. *Ingredients:* 2½ cups orange juice; ¼ cup lemon juice; 1½ cups sugar; 1 cup water; rind 2 oranges	2 heap. tblspoon.	100	0.94	0.23	74.68	312
Prune soufflé........... *Ingredients:* ½ cup stewed prunes (edible portion), white 1 egg.	2 " "	85	3.31	0.65	18.95	97
French dressing........ *Ingredients:* 4 tblspoon. olive oil; 1 tblspoon. vinegar; ¼ teaspoon salt; pepper.	1 dessert spoon	11	....	8.00	....	74
Mayonnaise dressing.... *Ingredients:* 2 eggs; 2 cups olive oil; 1 tblspoon. vinegar, or 1 tblspoon. lemon juice; salt, pepper, mustard.	1 tblspoon.	21	0.2	19.92	0.05	187
Honey................	1 "	30	.12	....	24.36	101
Cube sugar............	1 cube	7	....	....	7.00	29
Domino sugar..........	1 domino	6	....	....	6.00	25
Granulated sugar.......	1 heap. teaspoon	10	....	....	10.00	41
Powdered sugar........	1 " "	12	....	....	12.00	49
Maple sugar...........	1 cake	100	....	....	82.80	339
Almonds..............	10 large	15	3.15	8.23	2.60	100

VALUES OF THE ORDINARY FOODS PREPARED TO SERVE—*Continued*

Foodstuffs	Quantity	Weight (Gms.)	Protein (Gms.)	Fats (Gms.)	Carbohydrates	Total Calories
Brazil nuts	10 large	60	10.20	40.08	4.20	432
Chestnuts, roasted, as purchased	20 nuts	50	2.60	2.25	17.70	104
Cocoanut	1 slice	34	1.94	17.20	9.49	207
Filberts	10 nuts	10	1.56	6.53	1.30	72
Peanuts, as purchased	15 "	30	5.85	8.73	5.55	128
Pecans	10 large	30	3.30	21.36	3.99	229
Walnuts	10 "	42	7.73	27.05	5.46	306
Cocoa *Ingredients:* 1 heap. teaspoon cocoa; 1 heap. teaspoon sugar; ¾ cup milk; 1 tblspoon. cream.	1 cup	227	9.08	15.53	23.85	279
Coffee or tea *Ingredients* ¼ cup milk; 1 tblspoon. cream; 2 cubes sugar; coffee or tea.	1 "	246	2.80	7.64	17.83	156
Eggnog *Ingredients:* 1 egg; 1 heap. tblspoon. sugar; ¾ cup milk; 1 tblspoon. sherry.	1 glass	270	13.00	12.85	29.50	294

In discussing the energy obtained from different foods, it is important to distinguish between heat produced when substances are burned in the calorimeter and the heat that is available when used in the body, since it never happens that the combustible portion of a ration is entirely consumed in the body. The total food is never all digested, therefore it cannot all be absorbed and assimilated. Furthermore, the absorbed and assimilated proteins are never fully burned and there is usually an escape of unconsumed gases from the alimentary canal. As actual work is performed in the process of digestion, the term "net energy" has been introduced and applied to the amount of energy which is available after that used up in the digestion and preparation of the food for use in the body has been subtracted.

In calculating the fuel value represented by a particular menu, one deals with several carbohydrates in various proportions; similarly with fats and proteins derived from both animal and vegetable foods. Instead of computing the different foodstuffs separately, it will be found more convenient to use the average value given in the table on page 248 and

multiplying the total amounts of carbohydrate in the menu by this factor. The same may conveniently be done with the fats and proteins. The fuel value which any food represents is easily determined by using the factors in this table: Ascertain first the percentage of protein, fat and carbohydrate which the menu contains and multiply these several amounts by the factors given in this table; for example, oatmeal contains 7.6 per cent of water, 15.5 per cent of protein, 7.1 per cent of fat, 68.2 per cent of carbohydrates and 2 per cent of salts. One hundred grams of oatmeal represent energy, viz.:

From protein	15.1 × 4.0 =	60.40
From fat	7.1 × 9.4 =	63.90
From carbohydrates	68.2 × 4.0 =	272.80
Total		397.10

The total fuel value of one pound of dry oatmeal is obtained by multiplying this quantity by 4.5. The heat energy or fuel value of almost every known food is given in the table on page 702 (Analysis and Fuel Value of Foods, Volume I, Chapter XIX). These figures are sufficiently accurate for determining the caloric value of dietaries for institutional purposes or in private practice.

Method of Reckoning the Protein, Fat and Carbohydrate Rations for Diets of Definite Energy Values.—Voit's dietary standard for a man at moderately hard work is calculated for 16 per cent of the energy to be furnished by protein, 18 per cent by fat, and 66 per cent by carbohydrate. Where the total fuel value of the ration represents 3,000 calories, according to Coleman, the calculation is made as follows:

$$16 \text{ per cent of } 3{,}000 = \frac{480}{4.0} = 120 \text{ grams protein}$$

$$18 \text{ per cent of } 3{,}000 = \frac{540}{9.4} = 57 \text{ grams fat}$$

$$55 \text{ per cent of } 3{,}000 = \frac{19.80}{4.0} = 495 \text{ grams carbohydrate}$$

By the employment of Coleman's method the rations may be quite accurately determined for diets of any given energy value.

With the above facts before us it is easy to determine the caloric value contained in any food, provided the percentages of protein, fat and carbohydrate are known. These percentages multiplied by the figures given in

the table previously referred to and their results added will give the number of calories in 100 grams of food. It will not be such an arduous task to calculate the caloric value of a meal if one will remember the fuel values of the ordinary portions, viz.: roast beef, 357 calories; bread, 100 calories; butter, 150 calories; rice croquettes, 128 calories; a medium baked potato, 150 calories; tapioca pudding, 120 calories; sugar and cream with coffee, 100 calories—which will total 1,105 calories for the meal, or about one-third of the day's requirements.

FACTORS GOVERNING THE AMOUNT OF FOOD REQUIRED

The amount of food required to keep any person in a normal state of health and bodily equilibrium differs according to various circumstances, such, for instance, as the condition of rest or work, the kind of work, the training, the age, sex, size and weight of the body, restlessness or placidity, and even the individual peculiarities of the person. As an illustration, we will consider the body as an engine and the food consumed as the fuel for the engine. It has been proved as far as possible that the laws of conservation of matter and energy are followed by the human organism as they are in the engine; the body loses matter and energy, but they undergo transformation and are not destroyed in the body. Reasoning on this analogy, it may be assumed that whatever material is used in the body and however much energy is exhibited or heat evolved by it, both matter and energy have been derived from the food consumed in the process of digestion and assimilation and stored in the tissues.

Amount of Heat Lost by Body.—It is known that the heat of the body is generated by the oxidation of food or tissue substances, and also that the food required is proportional to the extent of the surface of the body. For instance, a small animal gives off, weight for weight, more heat than a large one. A large animal has a smaller cutaneous surface in proportion to size and weight than a small one, and a small animal a relatively larger surface area than a large one. For these reasons, it will be seen at a glance that a thin, angular, lean, lanky person loses more heat, according to weight, than a larger and more rotund person, a thin, premature infant more than a plump and well-developed child. After a consideration of many experiments on animals and human beings, Camerer came to the conclusion that an infant expends 100 calories, a child of 4 years expends 91.3 calories, a child of 12 years expends 57.7 calories and a man of 30 years expends 42.4 calories per kilogram of body weight. Consequently, the amount of heat lost by the body is an

important factor in the regulation of food, and to a great extent this is governed by the area of the body surface.

Weight of Body.—The amount of food required by the body, other things being equal, must be proportional to the weight of the body. The bodily heat is produced by the oxidation of food consumed or stored in the tissues. In a condition of rest, the tissues of the body are not called on for the production of heat and energy, but still there must be a minimum of food consumed to supply the energy utilized by, and the heat radiated from, the body. In a state of rest, a man of 154 pounds weight gives off 15 cubic feet of carbon dioxid in a period of 24 hours. The production of 1 cubic foot of carbon dioxid by combustion is accompanied by a liberation of heat equivalent to 160 foot-tons of energy, therefore $15 \times 160 = 2{,}400$ foot-tons of energy which are necessary to the maintenance of the body temperature and the performance of bodily functions during the state of rest. Therefore 1 calorie is equal to 1.54 foot-tons of energy, and 2,400 foot-tons is equal to about 3,696 calories for a person weighing 154 pounds.

Age.—According to Huebner(13), the younger the animal organism, the more rapid is the rate of growth. For instance, a child's body grows seven times more rapidly from one to three months than from six to nine months of age. It is correctly asserted that a child commonly loses a little weight for a few days after birth; but the average increase of weight up to three months is 3.6 pounds; from the third to the sixth month, 3.6 pounds; from the sixth to the ninth month, 3.4 pounds; and from the ninth to the twelfth month, 3 pounds. So the amount of food required by a normal child is in proportion to its rate of growth. Further consideration of food in childhood will be found in Volume II, Chapter XI.

Sex.—In anthropometric tables(14) that have been carefully compiled, the following data appear: (*a*) The most rapid growth occurs during the first five years after birth. In the first year the weight is trebled, in the second year it is nearly doubled. During this period the rate of growth is nearly identical in both sexes, only that boys are a little taller and heavier than girls. (*b*) During the next period, from five to ten years, the growth of boys is more rapid than that of girls, the weight of the former being from 2 to 3 pounds more, on the average. (*c*) During the third period, from ten to fifteen years, conditions are changed, the growth of girls taking the lead. From the age of twelve and a half to fourteen and a half years girls are taller than boys, and from the age of twelve and a half to fifteen and a half years their weight exceeds that

of boys of the same age by 3 or 4 pounds. (*d*) During the period from fifteen to twenty years, boys again come to the fore, and grow more rapidly than girls; the weight of boys increases yearly at the rate of 6.9 pounds, while that of girls is 2.75 pounds. (*e*) At the age of twenty-three years, boys have attained the limit of growth in height, but in breadth and weight they continue to increase. Girls, on the other hand, at about twenty years of age have attained their full height and weight, the latter remaining practically stationary until the age of twenty-five or even thirty years. (*f*) In general, adults begin to increase in weight after thirty-five years of age at the annual rate of three-quarters of a pound, a change most often unwelcome and not of advantage. The relative weights of men and women of the same age vary with the height, up to the height of 67 inches, men as a rule weighing more than women; but when over 67 inches in height, women are generally heavier than men of the same height and age, and especially after middle life the weight of women may greatly increase.

The generally accepted statement that the quantity of food ingested should be regulated by the size and weight of the body, offers no exception as regards the food of individuals of different sexes; the normal height and weight of a woman being less than those of a man, a smaller quantity of food than that required by a man should meet the needs of the average woman. An important point to note is that this smaller metabolism of food should be looked at from the standpoint of the personal equation relating to the sex of the individual, rather than the normally lower average size and weight of a woman. The following table illustrates this fact by showing the difference in the quantity of food taken daily by an active man and woman of identical age and height who were able to maintain their nutritive and nitrogenous equilibrium upon the amounts here designated:

	Protein	Fat	Carbohydrate	Cal.
Man	100 gm.	70 gm.	400 gm.	2,700
Woman	60 gm.	67 gm.	340 gm.	2,263

Atwater established the principle that the daily ration for a healthy woman should be 0.8 of that of a man. As a general rule, it is usually held that a woman requires about the same amount of protein and energy, weight for weight, as a man under similar circumstances. The amount of energy required to execute a definite amount of work is the same, whether it is performed by a woman or is done by a man; consequently, the supply of food should be the same. Tibbles says: "On the other hand,

it frequently happens that the expenditure of energy on the part of a woman to produce a definite amount of work is greater than that expended by a man doing the same identical work."

Food Requirements as Influenced by the Internal Secretions of Woman.—It is claimed that the internal secretion of the ovaries facilitates the oxidation of carbohydrates and the organized phosphorus of the food. There are other circumstances in the life of a woman which influence the demand for food. We know that their sex is subject to a wave of metabolic activity which is at its highest just before each menstrual period. During this metabolic disturbance the organism calls for an increase in the nitrogen metabolism, and a decrease in the carbon metabolism. There also appears at this time the formation of new blood cells, with an increasing amount of nerve force and general vigor. During the menstrual epoch there is a small loss of weight due to the increased excretion of carbonic acid and water, although the protein metabolism is diminished. There is an increase in weight during pregnancy, notwithstanding the increased combustion of non-nitrogenous elements; there is usually an increase in the size of the organs of lactation and parturition and a deposition of fat in the adipose tissue. These metabolic changes call for an increased amount of food to the daily ration, which practically means that the woman should consume about double the ordinary amount of protein, and have a greatly increased amount of the fuel foods.

Kind of Work.—The quantity of food necessary for an adult must be regulated rather by the amount of work performed than by the size, weight or other characteristics of the body. These requirements of the body are analogous to those of a machine, and well they may be, as the body itself is a living machine. It is a truism that the greater the expenditure of energy by a machine in the performance of work, the more fuel it will demand for the generation of that energy.

The human machinery performs work of two types, internal and external work. The internal work consists of that done by the organs of digestion, respiration and circulation, by the neuro-muscular system which maintains the body temperature, and muscle tone; and by the glandular system in keeping up the supply of the secretions and excretions. The external work includes the activities of the voluntary muscular system and the process of heat radiation from the body. According to Atwater's experiments, a man at rest in the respiratory calorimeter liberated during two hours 150 calories; while working a stationary bicycle for two hours, 500 calories; and while working the same machine against resistance for a period of two hours, 1,000 calories. It follows,

therefore, that the supply of food must keep pace with the amount of work to be done, or else the body tissues themselves will be used up as fuel for the generation of the energy expended.

Choice of Food.—The necessity for increasing the allowance of food in proportion to the amount of work the body is expected to do has always been recognized. Many research workers have made observation upon the food consumed by individuals who were allowed a free choice of food, and found that, with diets having the fuel values in "Standard Dietaries," nutrition of such individuals was fairly normal and the nitrogen balance in the state of equilibrium. They concluded, therefore, that the menus given fairly well represented the aliment required by these persons.

A close study of the table [1] on page 270 shows that when Americans and Europeans are free to choose their own food, they seldom select that which will yield less than 100 grams of protein per day.

When the choice of food rests with the individual, it is often found upon observation that a male rarely consumes less than 90 grams of protein per day. For economic and other reasons, there are many thousands who necessarily consume a much smaller quantity, because meat, fish, fowl, milk, eggs and cheese are dearer than bread, potatoes, rice, oatmeal, etc. Maurel(15), who has devoted much attention to the subject, claims that, "to maintain the body in nitrogen equilibrium when no muscular work is being performed, an adult in full health and vigor weighing 154 pounds requires for maintenance 105 grams of protein in a ration yielding about 2,600 calories of energy; a woman weighing 132 pounds requires 90 grams of protein in a ration yielding about 2,200 calories of energy." Our experience leads us to assert that these figures are probably very near the mark.

Rubner, in studying the specific dynamic action of foodstuffs, came to the conclusion that each type of food seemed to exert a more or less specific action upon the energy yielded; "so that, when the foodstuffs were fed separately, somewhat different energy values were required for the maintenance of body equilibrium." He observed a man who metabolized in fasting 2,042 calories; and when fed, 2,450 calories; in the form of sugar alone he metabolized 2,087 calories; when fed 2,450 calories in the form of meat alone, he metabolized 2,566 calories. This experiment clearly shows that the eating of protein increased the metabolism far more than could be done by eating the same number of calories in the form of carbohydrate and fat. Rubner believes that this specific dynamic action of protein involves the liberation of energy which has not come to

[1] Bulletin No. 52, p. 24, U. S. Dept. of Agric., and other sources.

EXAMPLES OF FOOD ACTUALLY CONSUMED

Subjects of the Observation Americans	Protein	Total Energy of Ration	Subjects of the Observation Europeans	Protein	Total Energy of Ration
	Grams	Calories		Grams	Calories
Tennessee students, 5 clubs, average	92	3,545	English weavers	151	3,475
Connecticut students, 5 clubs, average	106	3,280	Tailor	131	3,053
Maine students, 5 clubs, average	121	4,269	Lacemaker	120	3,200
Missouri students, 3 clubs, average	96	3,560	Mechanics	140	3,500
Knoxville students, 1 club	66–123	4,545	Ploughman	140	4,000
Japanese students, average	94	2,712	Peasants	69	2,850
Professor	123	2,343	Navy	172	4,050
French physicians, average	92	1,852	Dressmakers	56	1,800
Women students, average	85	2,696	Female basket-maker	90	2,200
German physicians, average	110	2,510	Seamstress	60	1,810
Professor	100	2,310	Schoolmistress	80	2,000
New York business men, average	109	3,235	Female clerk	85	2,020
			Scotland: 15 poor families	107	3,233
Working-class Averages:			Irish peasants	70	2,800
New York, 19 families	106	3,030	Germany: Physicians	92	1,852
Philadelphia, 26 families	109	3,235	Operatives and laborers	143	4,170
Chicago, 25 families	119	3,425	France: Operatives and laborers	140	3,800
New Jersey, 1 family	100	3,285	Sweden: Operatives and laborers	161	4,080
Virginia, 19 families	109	3,745	Russia: Operatives and laborers	113	3,061
Tennessee, 3 families	101	3,660	Japan: Poor people	71	2,026
Connecticut, 9 families	106	3,420	Jinrikisha man	158	5,050
Indiana, 1 family	90	3,285	Physician	59	2,580
California:			Malay: Student	96	2,723
Farmers' families	97	3,515	Male servant	73	3,151
Farm laborers	144	4,100	Bengal College:		
Canada:			(*a*) Bengalee	67	2,914
Farm laborers	108	3,585	(*b*) Bengalee students	44	1,292
Factory operatives	127	4,415	(*c*) Eurasians	87	2,420
Atwater's standard diet: Without work	90	2,700	Atwater's standard diet: Moderate work	125	3,500
Atwater's standard diet: Light work	112	3,000	Atwater's standard diet: Severe work	150	4,500

the surface of the tissues and which does not directly contribute to the support of their activities, although it aids in the maintenance of the body temperature. This apparent loss of a part of the fuel value of protein of an ordinary mixed diet is not a very important factor in the total body metabolism, since this specific dynamic action and the work of digestion and assimilation together make the total daily metabolism of energy only about one-tenth higher on a maintenance ration than when no food is eaten (Sherman).

Intensity of Muscular Activity.—In practice, it will often be difficult to estimate the mechanical equivalent of muscular work performed and still it is often necessary to make use of such indefinite terms as "active," "severe," etc., to describe the intensity of the exertion, and thus indicate in a general way the amount of work performed.

Atwater and Benedict(16), after a great deal of research and experimentation, epitomized the results of many work experiments with vigorous young men in the respiratory calorimeter, and have derived the following estimates of the average rates of metabolism, under different conditions of activity:

Man sleeping	65	calories	per	hour
Man sitting at rest	100	"	"	"
Man at light muscular exercise	170	"	"	"
Man at active muscular exercise......	290	"	"	"
Man at very severe muscular exercise..	600	"	"	"

From these estimates the requisite rations may be calculated as follows:

8 hours of sleep at 65 calories equal	520	calories
2 hours' light exercise at 170 calories equal....	340	"
8 hours' active exercise at 290 calories equal..	2,320	"
6 hours' sitting at rest at 100 calories equal...	600	"
Total food requirement for the day.....	3,780	calories

If the working day be spent in severe muscular exertions, the day's ration would be estimated at 5,060 calories. The requisite amount of calories for one in sedentary occupation, such as sitting at a desk, would require only 2,260 calories.

Tigerstedt(17) gives the following estimates of food requirements for

different occupations, indicating the intensity of work performed and the caloric needs:

2,001–2,400	calories	suffice	for a shoemaker
2,401–2,700	"	"	for a weaver
2,701–3,200	"	"	for a carpenter or mason
3,201–4,100	"	"	for a farm laborer
4,101–5,000	"	"	for an excavator
Over 5,000	"	"	for a lumberman

Graham Lusk(18) gives the following estimate of food in calories for the requisite occupations of women:

1,800 calories suffice for a seamstress using a needle

1,900–2,100	calories	suffice	for a seamstress using a machine
1,900–2,100	"	"	for bookbinders
2,300–2,900	"	"	for household servants
2,600–3,400	"	"	for washerwomen

Food requirements for occupations of men:

2,400–2,500	calories	suffice	for a tailor
2,700–2,800	"	"	for a bookbinder
3,100–3,200	"	"	for metal workers
3,200–3,300	"	"	for a painter
4,300–4,700	"	"	for stonemasons
5,000–5,400	"	"	for wood-sawyers

The estimated amount of food in calories for wood-sawyers emphasizes the fact that "wood-sawing is a strenuous occupation." This proverbial occupation has a scientific verification in the above statement and explains the disinclination of the hungry to engage in this useful occupation as well as the unpopularity of charitable wood yards.

On page 273 we give a table, taken from Lusk(19), of food values with cost per 1,000 calories for various fundamental foodstuffs and the percentage of protein contained in 1,000 calories.

The foods in the following table were purchased on the New York markets at the prices named. If the expense of cooking and serving and other overhead charges be included, the cost somewhat increases. Thus, at Childs' and other similar restaurants in New York, a portion of pork and beans served with three slices of bread and a pat of butter costs 20 cents, representing a well-balanced ration of 1,000 calories. The same could be

FOOD VALUES WITH COST PER 1,000 CALORIES

Foods	Cost in cents per 1,000 calories	Per cent of calories in protein
Glucose	1⅔	0
Corn meal	2	8
Wheat flour	2½	12
Oatmeal	2⁴/₅	13
Cane sugar	3⅓	0
Dried beans	4	19
Salt pork (fat)	4½	1
Rice	5	7
Wheat bread	5⅓	12
Oleomargarine	7½	0
Potatoes	7½	8
Butter	10	0
Milk	10	17
Smoked ham	10¾	34
Cheese	11⅔	25
Loin pork	12¼	18
Leg of mutton	16¼	30
Sirloin beef	24	37
Turkey	40¼	37

served in the home at a cost of about 10 cents, and most people, after ingesting such a repast would feel comfortably satisfied. Of course, it is understood that this menu would not satisfy everybody, especially not those in the upper classes who demand the luxuries of the world without rendering to the world an equivalent therefor.

Before leaving the subject of the relation of muscular activity to metabolism, it may be well to point out that the expenditure of energy in the muscular system does not depend simply upon the muscular movements performed, but to a considerable extent upon the degree of tension or tone maintained in the muscle while in a condition of rest. It is obvious to the surgeon that every living muscle is always in a state of tension from the fact that it gapes when its muscular sheath is cut. It is equally true that the degree of tension varies greatly under different conditions. Atwater and Benedict observed the differences between the metabolism of sleeping hours and that of the hours spent sitting up without muscular movements which are due largely to the more complete relaxation of the muscles during sleep. From this we find that there is in the resting muscles continual expenditure of energy which takes the form of muscular tension or tone, but ultimately appears as heat, so that the heat production or energy metabolism of the body in a condition of rest depends largely upon the degree of tension which normally exists in the muscle.

REGULATION OF BODY TEMPERATURE

The regulation of body temperature has been most ably discussed by Lusk(19), who avers that the maintenance of body heat beyond that of its usual environment requires a continual output of energy. This outgo of heat is controlled by mechanisms which permit of (*a*) variations in the reduction of temperature due to the quantity of blood brought to the surface of the skin—radiation, conduction and sweating—which is termed *physical regulation;* and (*b*) by variations in heat production brought about by an increase in the rate of oxidation in the body in response to the stimulus of external cold, which is termed *chemical regulation.* The increase in heat production following the ingestion of food (already considered in the previous pages of this work) may take the place of "chemical regulation" and thereby aid in the protection of loss of body temperature. The presence of a cushion of adipose tissue under the skin, together with suitable clothing for the external surface of the body also helps to keep down the loss of heat to the minimum of "physical regulation."

A sudden change downward in the external temperature increases the heat formation, augments the excretion of carbon dixoid, and the consumption of oxygen in warm blooded animals. A sudden change upward in the atmospheric temperature increases metabolism in warm-blooded animals, and this change is greater if the animal be placed in hot or cold water than if it be merely subjected to the influence of hot or cold air.

Von Noorden(20) explains the significance of an increase in heat production in cold weather, as due to extra precautions—food, clothing, etc.—to offset the increased heat losses incidental to the external temperature. Senator was the first to offer an explanation of this phenomenon. He held that the increased excretion of carbon dioxid was due to active muscular movements. No one at present questions but that there is an increase of about 100 per cent in carbon dioxid excretion after a cold bath, which is due, no doubt, to active muscular movements. It may be questioned that there may be a slight rise in carbon dioxid excretion without any visible movement or alteration in the tension of the muscles.

The question of an involuntary heat regulation has been definitely settled by Voit's animal experiments and also confirmed by Rubner's studies. The latter studied the metabolism of a man who was kept in the same cold room with different amounts of clothing, and he observed that when the subject was clothed sufficiently to be comfortable the "chemical regulation" was eliminated. Rubner emphasized the fact that suppres-

sion of shivering and the inhibition of muscular activity when subjected to external cold is an unnatural condition for a person subjected to great cold, and one that never occurs normally.

Physical Heat Regulation.—An increase in heat dissipation by means of conduction, radiation and evaporation comes into play as Nature's means of avoiding overheating; a diminution, on the other hand, prevents lowering of the body temperature. The amount of heat present in the body falls under the influence of cold, and it does not rise, even when the individual is placed in a warm bed, until active movements again furnish the necessary amount of heat to raise the temperature to normal. (Johansson.)

Chemical Heat Regulation.—Chemical heat regulation, like physical heat regulation, reaches a limit below which it cannot go. According to von Noorden, "The chemical energy set free in vital processes which is inseparably associated with the development of heat, cannot go below a certain limit. Only that form of heat production previously referred to as being associated with increased functional capacity of working organs can be excluded."

The extra heat required during cold weather is, in all probability, derived in most part through the activity of the muscles. It is a matter of every-day occurrence, in cold climates during winter weather, to see a man, a wagon-driver, for instance, stop and strenuously exercise his arms—if he did not do this, he would sit on the driver's box and shiver—a peculiar form of voluntary muscular activity whose function seems to be to increase heat production through increasing the internal work of the body. After all, it will be seen that the regulation of body temperature, even under exposure to cold, is brought about by the activity and tension of the muscles, the relation of which to metabolism and food requirement has just been considered.

Voit, in a discussion on the "heat balance" in warm and cold climates during both winter and summer, says that involuntary chemical heat regulation in the cold, which he admits exists within certain limits, is insufficient in the frozen zone. Here the inhabitants in addition to being clothed in furs, are driven to strenuous exercise in order to maintain body temperature. Only in so far as the movements increased are the food requirements augmented in the Arctic regions. The same law holds good in tropical countries—the food is lessened and the inhabitants move along the lines of least resistance. The enormous amount of food which the Eskimo can ingest with impunity has already been referred to, and emphasizes the point of the greater functional capacity of the alimentary

canal in the natives of cold countries, as compared with the abstemiousness of the Arab and his ability to greater endurance of hunger and thirst. Our digestive system and nervous mechanism which controls it are affected both by heat and cold, and as a result most people consume more food in winter than in summer, although the body requirements remain practically the same all the time.

The Surface Areas of the Skin in Heat Regulation.—The greatest loss of heat is from the body surface. Fully 90 per cent and upward of the whole amount takes place by radiation, conduction and evaporation from the skin. The actual figures are given in a tabulation on the next page. The reason the skin is able to act as one of the most important organs for regulating body temperature are: (*a*) that it offers a large surface for radiation, (*b*) it contains a large amount of blood, and (*c*) the quantity of the circulating fluid is greater under the circumstances which demand a loss of heat and *vice versa.* The effects of a hot atmosphere on the skin surface, through the nerve fibers, causes a relaxation of the muscular fibers of the blood vessels; and, as a result, the skin becomes full-blooded, hot and sweating—leading to much loss of heat.

On the other hand, with a low temperature, the blood vessels shrink, the skin becomes pale and cold and dry; thus by means of a self-regulating apparatus, the skin is the most important organ for the regulation of body temperature.

It is a recognized fact that size, height and weight are important factors in heat regulation. Actual experiments upon animals, says Howell, "show that small animals produce more heat in proportion to their weight than larger animals of the same species, owing to the relatively larger surface, and, therefore, greater loss of heat." This point was first emphasized by Rubner and, according to his law, the metabolism is proportional to the surface area of the body, or, in other words, for the same amount of surface area there will be the same production of heat. On the following page will be found a table giving the surface area in square meters of people of different heights and weights, showing the requisite calories during a 24-hour period, to which we will refer later.

Regulation of Heat Loss.—The regulation of heat loss is the most important problem which the physiologists of to-day have to elucidate(21). Experiments plainly show that heat regulation is very complex; the body, as we have just emphasized, possesses a means of controlling heat loss as well as the production of heat, and under normal conditions both functions are in active use.

HEAT PRODUCTION IN SLEEP (MINIMAL RESTING METABOLISM—"GRUNDUMSATZ") CALCULATED FOR TWENTY-FOUR HOURS[1]

Number	Name	Height, cm.	Weight, kg.	Calories in 24 hours	Calories per hour and kg.	Body surface, sq. m.	Calories per sq. meter of body surface	Number of days during which experiment continued	Constitution fat; muscular system
1	Dr. Andersson	188	90.4	1,773	0.82	2,479	715	2	Small amount of fat, very strong.
2	Professor A.	(?)	83.5	1,670	0.83	2,353	710	1	Somewhat corpulent, strong active sportsman.
2a	J. C. W.	178	76.0	1,853	1.02	2,209	839	5	Medium; highly trained.
2b	J. C. W.	178	76.0	1,798	0.99	2,209	814	4	
3	Servant	176	75.6	1,670	0.92	2,201	759	1	
4	Dr. Johannsson	180	73.0	1,632	0.93	2,150	759	8	Slight; medium muscles, little training.
5	Stud. Med.	171	72.7	1,657	0.95	2,145	773	1	
6	Dr. Clopatt	173.5	72.6	1,550	0.89	2,142	724	2	Medium; good muscles.
7	Engineer	190.5	71.2	1,787	1.05	2.115	845	1	Poor in fat; very good muscles.
8	A. W. S.	176	70.0	1,620	0.97	2,091	775	3	Normal; very good muscles, highly trained.
10	E. O.	173	70.0	1,661	0.99	2,091	794	33	Normal; very good muscles, highly trained.
11	Cand. Med.	(?)	64.9	1,475	0.95	1,988	742	4	Slight; good muscles, highly trained.
12	J. F. S.	171	65.0	1,445	0.93	1,990	726	9	Slight; good muscles, highly trained.
13	Cand. Med.	(?)	63.0	1,492	0.99	1,950	765	1	Slight; normal; trained.
14	Dr. Bjerre	174.5	63.0	1,418	0.94	1,950	727	1	Slight; normal.
15	Dr. Siven	162.5	62.5	1,431	0.95	1,939	738	5	Medium; medium muscles.
16	Dr. Bergmann	172	57.15	1,560	1.14	1,836	850	2	Slight; strong.
17	"Dr."	159	54.98	1,590	1.21	1,780	893	1	Thin (?).

[1] From "Metabolism and Practical Medicine," by von Noorden.

As we have already seen, heat loss from our bodies is accounted for as follows:

(*a*) From expirations from the lungs.
(*b*) By evaporation of sweat from the skin.
(*c*) By conduction and radiation from the skin.
(*d*) Through the excreta, urine, feces, saliva.

The approximate percentages of heat lost in this manner, according to Vierodt, are as follows:

(*a*) From expirations from lungs	3.5 per cent or	84 cal.
(*b*) Vaporization of water from lungs	7.2 " " "	182 "
(*c*) By evaporation from the skin	14.5 " " "	364 "
(*d*) By conduction and radiation from skin	73.0 " " "	1,792 "
(*e*) By urine and feces	1.8 " " "	48 "
Total daily loss		2,470 cal.

Howell, in commenting on this observation, says the relative importance of these factors will, of course, vary with conditions; for instance, a high external temperature will aid in the diminishing loss from radiation, while increasing that from evaporation, owing to the greater production of sweat.

Many examples may be given of the power which the body possesses of resisting the effects of a high temperature, in virtue of evaporation from the skin. Blagden and others supported a temperature varying between 92°–100° C. (198°–212° F.) in dry air for several minutes; and in a subsequent experiment the former remained eight minutes in a temperature of 126.5° C. (260° F.). According to Carpenter:

> The workmen of Sir F. Chantrey were accustomed to enter a furnace, in which his molds were dried, while the floor was red hot, and a thermometer in the air stood at 177.8° C. (350° F.), and Chabert, the fire-king, was in the habit of entering an oven, the temperature of which was from 205°-315° C. (400°-600° F.) (Carpenter.)

But such heats are not tolerable when the air is moist as well as hot, though this condition prevents evaporation from the body. C. James states that, in the vapor baths of Nero, he was almost suffocated in a temperature of 44.5° C. (112° F.), while in the caves of Testaccio, in which the air is dry, he was but little incommoded by a temperature of 80° C. (176° F.). In the former, evaporation from the skin was impossible; in the latter it was abundant, and the layer of vapor which would rise from all the surface of the body would, by its slowly conducting power,

defend it for a time from the full action of the external heat. (Kirk's "Handbook of Physiology.")

Under ordinary conditions we are able by suitable clothing to increase or diminish the amount of heat lost by the skin. The ways by which the skin may be rendered more efficient as a cooling apparatus, too, by exposure, by baths, and by other means which man instinctively adopts for lowering his temperature when necessary, are too well known to require more than passing mention.

Production of Heat During Rest.—The production of heat during rest varies in different individuals according to height, weight, to the superficial area of their bodies, and to their condition of health.

In the following table is reproduced the metabolism of adult males per minute—worked out according to Zunt's method. The subjects of these experiments were in absolute muscular rest during the observation. The age, height and weight are recorded, the respiratory quotient ascertained, and the total calories for the twenty-four hours estimated and the calories per hour per kilogram of body weight. The minimum resting metabolism is estimated by measurement of the gaseous interchange during sleep or during fasting, at least twelve hours after the ingestion of food. Von Noorden(20) in his research on this point "replaces the quantity of carbon dioxid excreted by the heat factor which can be deduced from the ratio existing between the quantity of carbon dioxid eliminated and the amount of heat formed during twenty-four hours." Atwater's calorimetric experiments are especially valuable, both on account of the care with which they were carried out and by reason of their repeated repetition.

The table on the following page shows height, weight and the area of body surface in square meters, the calories per hour per kilogram of body weight and total calories for the twenty-four hour period. Even these numbers derived from resting metabolism, possibly do not represent the minimal metabolism during rest, since deep sleep does not usually extend over more than from six to eight hours.

Résumé.—From previous discussion of this subject, it will be observed that although individuals of excessive weight have a greater metabolism than those of slighter build, yet the metabolism, according to von Noorden, does not increase in direct proportion to weight, but less rapidly. Therefore, when considering the unit of weight to metabolism, it is well to recollect it is usually smaller in the case of heavy than of light individuals. It will be seen, from carefully studying the table, that absolute metabolism does not run parallel with body weight, but more nearly proportionally

GASEOUS EXCHANGE PER MINUTE, AND HEAT PRODUCTION IN TWENTY-FOUR HOURS, DURING ABSOLUTE MUSCULAR REST IN THE FASTING CONDITION[1]

No.	Name	Age	Height (cm.)	Weight (kg.)	Expired Air	R. Q.	Per Kg.		Per Individual		Calories in 24 hours	Calories per hour and kg.	Constitution
							O_2 (c.c.)	CO_2 (c.c.)	O_2 (c.c.)	CO_2 (c.c.)			
1	Rud.......	24	148	43.2	5.6	750	4.53	3.40	195.8	146.9	1,333	1.29	Very small and thin
2	Dr. Sch....	24	(?)	48.0	...	783	3.68	2.88	176.8	156.4	1,214	1.05	Small, thin, good muscles
3	L.........	30	153	50.8	5.9	826	3.73	3.08	189.4	182.8	1,315	1.08	Small, thin
4	Rutt......	36	153	53.0	5.5	833	4.14	3.45	219.5	168.2	1,527	1.20	Poor in fat
5	W........	56	170	56.5	...	766	3.93	2.98	222.0	188.0	1,519	1.11	Poor in fat
6	B.........	32	161	58.0	5.6	760	3.81	2.90	221.2	162.5	1,510	1.08	Normal
7	Dr. K.....	(?)	172	64.0	...	...	....	2.94	...	188.0	1,656	1.07	(?)
8	Prof. Z....	43	161	65.0	4.5	740	3.39	2.50	220.6	162.5	1,498	0.96	Normal
9	Dr. M. L..	25	167	67.5	5.2	830	3.43	2.86	231.3	192.5	1,608	0.99	Poor in fat; very muscular
10	Dr. L. Z...	22	167	67.5	...	865	3.43	2.97	231.3	200.2	1,621	1.00	Poor in fat; very muscular
11	Dr. J......	30	180	73.0	...	...	....	2.41	...	175.6	1,584	0.905	Normal
12	Dr. Jaq....	34	170	82.0	...	788	2.76	2.17	226.3	178.3	1,556	0.79	Rich in fat, not corpulent; good muscles
13	Sp........	29	185	82.7	7.0	757	3.60	2.72	297.6?	225.4	2,030?	1.02	Poor in fat; very muscular
14	Schm......	22	176	88.3	6.9	814	3.30	2.69	291.7?	237.4	2,019?	0.95	Normal fat; very muscular

[1] From Metabolism and Practical Medicine, by von Noorden.

with the surface area of the body. Bergman was convinced of this fact several decades ago, and Rubner and von Noorden have confirmed it by numerous experiments.

Again we reiterate that a tall thin man has a greater area of body surface for a given weight than a short stout man. "Besides, normal men may vary as much as 10 per cent from the average in relation of surface area to body weight. The spare thin man, besides having a greater surface area, also differs from the stout short man in that he has a greater percentage of actual protoplasm." Now, since the metabolism of the body depends upon its weight of protoplasm (active tissue) rather than total corporeal weight, we have here, according to Sherman(4), an important reason for assuming that the food requirement will be greater in the tall than in the short individual of the same weight. Von Noorden tested this question by observing two individuals of the same weight but different build for a period of one day. His results were as follows:

Thin man ....Weight, 71.0 kilo., 2,392 cal., 33.6 cal. per kilo.
Stout man ....Weight, 73.6 kilo., 2,136 cal., 29.0 cal. per kilo.

Finally, for the majority of individuals, it will be safe in calculating a dietary to proceed as if the form, height, weight and body surface area were constant without falling into serious error.

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CHAPTER X

GENERAL NUTRITION AND MINERAL METABOLISM

General Considerations.
Metabolism: Anabolism and Catabolism.
Metabolism Experiments: Balance of Income and Outgo; Respiratory Quotient.
Factors Which Affect Metabolism: Consumption of Food; Fasting; Effect of Nitrogenous Diet on Metabolism; Carbohydrates as Protein Sparers; Fat Versus Carbohydrates as Protein Sparers; Gelatin as a Protein Sparer; Alcohol as a Protein Sparer; Metabolism of Water; Metabolism of Mineral Substances; Acid-Forming and Base-Forming Elements.

GENERAL CONSIDERATIONS

In the study of metabolism, we become acquainted with the exchanges of material by which vital phenomena are produced, and the conversion of chemical force into "living energy." The various metabolic processes are not the same in all organs and tissues. For instance, the functions of the liver and of the pancreas are distinctly different. Valuable data have been obtained by physiologists who have painstakingly studied the metabolic changes in isolated parts of the body. By the maintenance of artificial circulation through "surviving" organs, completely severed from their normal relations, the life of the cells may be continued for many hours. Chemical examination of such tissues has thrown light on their metabolic processes; under such conditions changes in the composition of the nutrients in the circulating medium point to the nutrient demands, the waste, or the specific elaborations of the cells. Furthermore, by the exclusion of individual organs, their normal activity may be inferred from the absence of certain functions. The metabolic work of the spleen, kidneys and thyroid has been studied by observations on individuals who have in whole or in part, been deprived of these organs through surgical intervention. Moreover, the changes in metabolism which go hand-in-hand with diverse pathological conditions of the body have also contributed to our understanding of the subject.

It is readily understood that many difficulties beset the path of the investigator who studies the metabolism of individual organs, although the problems involved are of the greatest importance in physiology. Professor Lafayette B. Mendel, in discussing this question, says:

The income (food and oxygen) and the outgo (excretions, urine and feces) have been determined with accuracy, under the most varied conditions, while the understanding of the intermediate processes is still largely a matter of "gaps and guesses." The body is constantly undergoing losses, which must be made good sooner or later. New material must be contributed to replace the wear and tear of the body. Certain losses may only be temporary, as in the secretion of milk, the production of eggs, the ejection of semen, and the menstrual flow, all of which, however, are relatively of little importance. The lungs give off carbon dioxid and water, the kidneys water, inorganic salts and nitrogenous compounds. The skin eliminates water and inorganic salts and traces of nitrogenous compounds, and with the feces there is excreted a residue of the digestive secretions, waste from the alimentary canal and indigestible particles of food.

METABOLISM

In the study of the intricate processes of digestion, assimilation and absorption, we traced the food through the digestive tract, and we come now to a consideration of those processes which are fundamentally important ones—the fate of the foodstuffs in metabolism, all others being only means leading toward the end. During digestion, assimilation, respiration and excretion, the food ingested undergoes many and various changes, breaking down into simpler compounds or undergoing transmutation into more complex substances. This change(1) of matter into potential and dynamic energy is termed *metabolism*. The body converts potential into kinetic energy by metabolism in the body. The potential energy of the aliment, through the processes of digestion, is transformed into the actual energy of heat and mechanical labor. There is no difference in these changes between man and other vertebrates, though there may be slight variations in details; the end products are the same. It is admitted that there may be slight differences in the nervous and intellectual processes, though at present this is "seen through a glass darkly."

Anabolism and Catabolism.—For the sake of clearness, these chemical changes are classified as follows:

First, there are certain chemical processes in the animal economy where simpler substances are converted into more complex ones, which is constructive metabolism, *i.e.,* the process of the assimilation of nutritive material from the alimentary canal and its conversion into the living substance. This process is called *anabolism*. An example of this upbuild-

ing metabolic change is found in the first change which the fats undergo after saponification. This change has already been explained (in Volume I, Chapter VII, The Physiology of Absorption, to which the reader is referred). In this anabolic change the fatty acids combine with glycerin to form molecules of neutral fat. The latter molecule contains three parts of fatty acid to one of glycerin, and is therefore much more complex than the molecules from which it is built up.

Second, the complex food materials or tissue constituents are oxidized and broken down into simpler materials, and finally excreted. Preceding this oxidative change, the energy of the complex material is given up in the form of heat, motion, etc. The body is never stable; while growth and nutrition progress, destruction or demolition constantly go on. This retrograde metabolism is called *catabolism,* and most of the chemical changes taking place in the animal body belong to this group.

It is readily seen that analysis and synthesis play their part coincidently or successively in the various phases of the activity of the living substance; and when the effects of destructive or catabolic change are no longer offset by appropriate anabolic processes, the functions may become impaired or may cease altogether. It will be seen, therefore, that the continuity of life depends upon perfect metabolism. Indeed, it is well said that "metabolism, in its entirety, is made up of a series of processes both catabolic and anabolic. In vegetable life the synthetic changes predominate, and highly complex compounds are built up, one might say, directly from the elements"(2). In animal life, on the other hand, catabolism prevails to a large extent, so that in these late years physiologists are accustomed to point out quantitative rather than qualitative differences between animal and vegetable life. Foodstuffs, for instance, are ingested in the form of complex molecules of carbohydrate, fat and protein, and during the varied processes of digestion, absorption and assimilation undergo more or less complete combustion. Oxygen unites with carbon to form carbon dioxid and with hydrogen to form water; the nitrogen of the highly complex protein substances reappears in combination with carbon, hydrogen and oxygen, as urea, uric acid, hippuric acid, etc., and the sulphur and phosphorus of organic compounds are eliminated after oxidation to sulphuric acid. It is through these catabolic processes that the potential energy of the foodstuffs is ultimately transformed to maintain body temperature, nitrogen equilibrium, and furnish the necessary energy for the wear and tear of the body. In the cleavage of complex compounds to simpler ones, a portion of the potential energy of the ingested food, perhaps stored up temporarily in the form

of glycogen or tissue fat, becomes *kinetic*. In some cases the combustion proceeds to the same end-products which rise by oxidation outside of the body, or, again, the compounds which are discharged by the elimination of the products of catabolic changes may be completely oxidized or even undergo subsequent synthesis, as is true of such substances as urea and hippuric acid.

METABOLISM EXPERIMENTS

Balance of Income and Outgo.—A balance sheet of the anabolic *income* and the catabolic *outgo* will graphically show the exact amount of matter and energy used daily in the body. According to Tibbles(1), the *income* consists of (*a*) *matter:* food, drink and oxygen of the air; (*b*) *energy:* the potential energy of food and drink. The *outgo* consists of (*a*) *matter:* in the urine, feces, perspiration and breath: (*b*) *energy:* the potential energy of urine, feces, products of perspiration and respiration. A scientific balance sheet of this process would graphically "show the amount of C, N, H, O, P, S, Cl, K, Na, Mg, and Fe in the income and outgo, and it would also show the compounds in the excreta, including proteins, fats, carbohydrates, water and carbon dioxid."

Many observers have worked over this problem. Two of the most explicit results are the following, given below. The first of Ranke(3), the second by Pettenkofer and Voit(4), as shown in the following tabulation from Tibbles(1):

EXCHANGE OF MATERIAL WITH STANDARD DIETS

Income				Expenditure			
Food	Amount in Gms.	Nitrogen (Gms.)	Carbon (Gms.)	Excretions	Nitrogen (Gms.)	Carbon (Gms.)	Water (Gms.)
Protein	100	15.5	53.0	Urine	14.4	6.16	....
Fat	100	....	79.0	Feces	1.1	10.84	....
Carbohydrate	250	....	93.0	Respiration (CO_2)	....	208.00	....
Total		15.5	225.0	Total	15.5	225.00	....
Protein	137	19.5	315.5	Urine	17.4	12.70	1279
Fat	117			Feces	2.1	14.50	83
Carbohydrate	352			Respiration	....	248.60	828
Water	2016						
Total		19.5	315.5	Total	19.5	275.80	2190

The researches and results of these men, now classical, have never been assailed; but they are not so complete as the researches conducted by Atwater(5) and his coworkers. Few investigators have carried out their experiments with the completeness of those conducted by Atwater from 1897 to 1907. Atwater and his colleagues selected for their observations

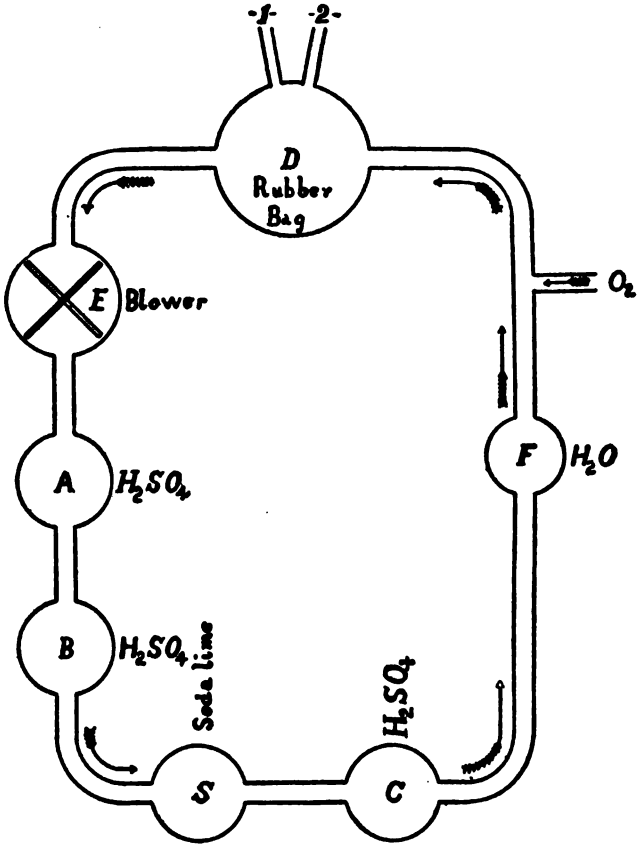

Fig. 5.—Calorimeter.—Devised by Atwater and Rosa, Bull. 63, U. S. Dept. Agric., 1899. Recent improvements on same by Atwater and Benedict—"A Respiration Calorimeter"—Carnegie Institution of Washington, 1905, used in Howell's Physiology, 6th Edition, Saunders, 1915.

a man in normal health, with good digestion. A well-balanced palatable dietary was provided; it was well cooked, accurately sampled, and carefully analyzed. The quantities of nitrogen and carbon were sufficient to maintain equilibrium during work or rest. Four days before the experiment was begun a preliminary digestion experiment was made to determine the requisite food for equilibrium maintenance.

SUMMARY OF METABOLISM EXPERIMENTS[1]

1. Income and Outgo of Nitrogen and Carbon

Kind of Experiment—Subject—Duration	Nitrogen: Grams in:				Carbon: Grams in:					Body: Gain + Loss − (Grams)	
	Food	Feces	Urine	Gain + Loss −	Food	Feces	Urine	Respiratory products	Gain + Loss −	Protein	Fat
(1) Rest experiments:											
E. O.[2]: Average of 33 days	18.8	1.2	18.5	−0.9	253.4	10.6	12.9	218.8	+11.1	−5.6	18.4
A. W. S.: Average of 3 days....	15.5	1.0	15.4	−0.9	215.2	9.0	10.8	217.4	−22.0	−5.6	−24.9
J. F. S.[3]: Average of 12 days	16.5	1.1	15.7	−0.3	250.0	9.7	11.6	207.8	+20.9	−2.0	28.9
Rest: Average of 13 experiments	18.0	1.2	17.6	−0.8	249.7	10.3	12.4	216.1	+10.8	−4.8	17.5
(2) Work experiments:											
E. O.[4]: Average of 8 days......	19.5	1.9	17.3	+0.3	355.1	16.3	12.6	358.9	−32.7	2.0	−44.1
J. F. S.[5]: Average of 12 days...	16.1	1.0	16.0	−1.0	327.7	10.2	11.2	330.4	−24.1	−6.1	−27.4
Average of 6 work experiments.	17.2	1.3	16.4	−0.5	336.8	12.2	11.7	339.9	−26.9	−3.4	−33.0
Average of 19 experiments in rest and work..............	17.7	1.2	17.2	−0.7	277.2	10.9	12.2	255.2	− 1.1	−4.4	1.6

2. INCOME AND OUTGO OF ENERGY: CALORIES

HEAT MEASURED IN THE ABOVE EXPERIMENTS	Heat of Food	Heat of Feces	Heat of Urine	Net Income: Material oxidized	Net Outgo: Heat measured	Difference between income and outgo	
						Calories	Per cent
(1) Rest experiments:							
E. O.[6]: Average of 33 days	2,541	116	145	2,280	2,272	− 8	−3.5
A.W. S.: Average of 3 days	2,480	100	126	2,304	2,279	−25	−1.1
J. F. S.[7]: Average of 12 days	2,361	110	134	2,117	2,136	+19	+0.9
Average of 13 rest experiments	2,636	113	141	2,244	2,241	− 3	−0.1
(2) Work experiments:							
E. O.[8]: Average of 8 days	3,770	179	129	3,865	3,829	−36	−0.9
J. F. S.[9]: Average of 12 days	3,491	113	127	3,539	3,540	+ 1	...
Average of work experiments	3,584	135	128	3,647	3,637	−10	−0.3
Average of all experiments	2,926	120	137	2,688	2,682	− 6	−0.2

1 Bull. 109, p. 126-127, U. S. Department of Agriculture.
2 Von Noorden in "Metabolism and Practical Medicine."
3 Tibbles in "Food in Health and Disease."
4 Hall in "Nutrition and Dietetics."
5 Ranke in "Einwirkung des Tropenklimas auf die Ernährung des Menschen."
6 Von Noorden, *Ibid.*
7 Tibbles, *Ibid.*
8 Hall, *Ibid.*
9 Ranke, *Ibid.*

During these preliminary digestion experiments the man was ordered to work and rest just as he was to do while in the respiratory calorimeter, shown in the accompanying illustration(6).

The results of some of these calorimetric investigations are given in the following tables, a study of which will show that the body has considerable power of adjusting the expenditure of nitrogen to the income. The catabolized protein cannot be calculated as an exact measure of permanent demands of the body, nor as a measure of the usual requirements of a man at work; but experiments of this type show that the body requires a specific quantity of energy-producing foodstuffs for sustenance, and an additional amount to supply the demands for bodily wear and tear.

According to Atwater, the results of a rest experiment during a period of 45 days were as follows: Net income, 2,255 calories; net expenditure, 2,255 calories. During a period of light work lasting for 65 days, the net income amounted to 2,690 calories, the net expenditure to 2,628 calories. During the 45 days of rest the elimination of energy was estimated to be: By the skin and lungs, 1,669; in the evaporation of water from the lungs, 550; in the urine and feces, 31; total, 2,250 calories. During a period of 20 days of work the heat eliminated by means of radiation and conduction from the skin and air in the lungs amount to 2,777; in the evaporation of water from the lungs, 1,126; in the urine and feces, 19; by muscular work, 234; total, 3,656 calories.

The Respiratory Quotient.—It has always been held that the energy expended by the body is measured by the quantity of carbon dioxid excreted. Parkes determined that during rest a man of 150 pounds excreted daily 15 cubic feet of carbon dioxid; that 1 cubic foot of gas resulting from combustion meant the expenditure of 160 foot-tons of energy, and 15 cubic feet 2,400 foot-tons of energy, the equivalent of about 1,560 calories. He estimated the amount of carbon dioxid excreted hourly during a period of rest to be 0.62 cubic feet; during a period of hard work, 1.66; and during laborious work, 2.75 cubic feet. Atwater and Benedict proved that carbon dioxid excretion varies with the condition. The average daily amount during rest and fasting was 676 grams; during rest with food, 812 grams; during work with carbohydrate diet, 1,820 grams; during work with fat diet, 1,665 grams; and during work with mixed diet, 1,475 grams. Parkes estimated the daily expenditure of energy during rest to be 1,600 calories; during moderate work, 2,600; and during hard work, 3,200 calories.

The significance of the *respiratory quotient* in metabolism has been

studied extensively by Zuntz(7) of Germany and Atwater(5) in this country. The respiratory quotient is the most delicate test of the carbonaceous metabolism of the organism; it is the ratio of the carbon dioxid exhaled to the oxygen consumed. Correct values for the gaseous interchange and for the respiratory quotient can be obtained only when delicate technical precautions are observed—with the Atwater-Rosa calorimeter, or by Zuntz's method. Atwater at the beginning of each experiment directs (for a period of from three to ten minutes, varying with practice and with the capability of control on the part of the individual examined) that the ventilation is to be slightly increased, and as a result of the greater activity of the respiratory musculature, the consumption of oxygen is raised somewhat above the amount consumed during rest. Von Noorden says, "As a result of the forced respiration, too much carbonic acid is withdrawn from the blood, and so the respiratory quotient is found to be too high. Subsequent to the period of forced respiration, there follows for some minutes one of quieter respiration, during which there is a compensatory diminution in the carbon dioxid output, below the amount that is formed, with the result that the respiratory quotient is too low. Only after these two periods are passed does the gaseous exchange become regular and the normal values for O_2, CO_2, and the respiratory quotient can be determined."

The respiratory quotient is affected by numerous other, frequently accidental, influences, apart from the purely mechanical ones associated with respiration, and so conclusions can be drawn only when the results obtained by numerous experiments are found to agree.

The tabulation below from the experiments of Atwater and Benedict [1] shows:

EFFECTS OF FOOD AND WORK ON RESPIRATION

CONDITIONS	Heat measured (Calories)	CO_2 exhaled (Liters)	Oxygen consumed (Liters)	Respiratory quotient
Rest: Fasting	2,197	342.2	473.6	.727
" Ordinary mixed diet	2,287	404.5	469.4	.862
Moderate work:				
Fat diet	3,570	613.9	737.5	.832
Carbohydrate diet	3,699	655.1	757.1	.865
Hard work:				
Fat diet	5,128	856.6	1,058.9	.809
Carbohydrate diet	5,142	929.2	1,025.9	.906

[1] Bull. 109, U. S. Dept. Agric.

The respiratory quotient is calculated as follows: Divide the amount of carbon dioxid exhaled by the amount of oxygen consumed; one liter of carbon dioxid weighs 1.9642 grams, and one liter of oxygen 1.4286 grams, and the corresponding factors are $1 \div 1.9642 = 0.5091$, and $1 \div 1.4286 = 0.7$. The amount of carbon dioxid exhaled by a man in one experiment lasting several days was 3,248.3 grams and oxygen consumed 2,755.3 grams.

The values of the respiratory quotient, *i.e.*, the proportion of the O_2 intake to the O_2 output in the form of CO_2—

$$\frac{\text{Gram } O_2 \text{ in } CO_2}{\text{Gram } O_2} = \frac{\text{c.c. } CO_2}{\text{c.c. } O_2}$$

on a fat and carbohydrate dietary can easily be calculated from the elementary composition of these food principles.

According to von Noorden(8):

> In the case of these two foodstuffs, decomposition products of different elementary composition, which would require to be taken into consideration, do not, as a rule, appear either in the urine or in the feces in appreciable quantities. It is quite different in the case of protein, where the amounts of C, H, O, and S appearing in the urine and feces must be deducted in order to ascertain the quantity of oxygen required for the formation of H_2O and CO_2. As its amount varies in different experiments, and as the nature of the calculations differs not only for different proteins, but also as carried out by different authors, so the statements vary as to the amount of oxygen requisite for the combustion of the protein, and also as to the amount of CO_2 expired. For these reasons the respiratory quotient, as well as the physiological and physical heat values, vary in the case of a protein dietary.

The amount of the respiratory quotient for the most common substances, according to von Noorden, is as follows:

Starch, etc.	1.00
Fat	0.707
Protein	0.809
Alcohol	0.667

"The calculated theoretical limiting values of the respiratory quotient, in the case of the exclusive combustion of the carbohydrates, or of fats, are usually not attained within the organism, since protein is invariably oxidized along with these bodies. If we take for the fasting state (the individual being in fair average condition) the proportion on the part of the protein in the total energy exchange of the organism as 15 per cent

of the latter, then the limiting values of the respiratory quotient, with a distribution of the energy exchange, are as follows:

With 15 per cent (energy value) protein, 85 per cent (energy value) carbohydrate = 0.971 respiratory quotient.

With 15 per cent (energy value) protein, 85 per cent (energy value) fat = 0.722 respiratory quotient.

"Under normal nutritive conditions these values neither rise above this level nor fall below it, provided that the oxidation of the foodstuffs to their end-products is complete, and that no intermediate products appear."

If the experimental technic be correct, and the analysis accurate, the height of the respiratory quotient gives us an idea as to the nature of the matter which has undergone metabolism in the organism. The course of the respiratory quotient has thus given definite information as to the rapidity with which carbohydrate and other food materials introduced into the body have undergone metabolism(9). The respiratory quotient is always increased after a hearty meal. All foodstuffs rich in carbon augment the outgo of carbon dioxid.

According to William Tibbles(1), "A strictly carbohydrate diet is possible only for short periods during which the respiratory quotient rises to unity or nearly so." A dietary consisting largely of fat lowers the respiratory quotient, but increases the expenditure of carbon dioxid, while, on the other hand, alcohol and the ethereal oils diminish the outgo of carbon dioxid. Again the respiratory quotient falls in the formation of sugar from protein, for which considerable oxygen intake is necessary without corresponding quantities of carbon dioxid being expired, if the glucose formed is either stored as glycogen or excreted in the urine. "Rest causes a fall in the respiratory quotient to about 0.7 or 0.8, but muscular activity causes an increase in the intake of oxygen and the output of carbon dioxid, especially the latter, and the respiratory quotient rises to 0.8 to 0.9."

FACTORS WHICH AFFECT METABOLISM

According to Sherman(10):

The calorimetric method of studying total metabolism permits of experiments being carried out very quickly, and is therefore especially useful for the direct investigation of conditions which affect metabolism at once, *e.g.*, muscular work, work of digestion, etc. Moreover, the apparatus can be made portable and thus be carried by the subject like a knapsack in experiments on marching, mountain climbing, or bicycling. The observations cannot be made continuous, but the probable results for the 24 hours' metabolism can be estimated by the data obtained during frequent short periods at different times of the day and night.

Assuming that the total nitrogen and carbon of the absorbed food existed in the form of protein, fat and carbohydrates, and that the amount of carbohydrates in the body is constant from day to day, it is only necessary to determine the carbon dioxid of the expired air and the carbon and nitrogen of the waste products in order to calculate the amounts of material oxidized and of energy liberated in the body. Experiments of this sort have played a most important part in the development of our knowledge of nutrition. The calculations are usually based on the following average analyses of protein and body fat:

	Protein	Fat
Carbon	53	76.5
Nitrogen	16	
Hydrogen	7	12
Oxygen	23	11.5
Sulphur	1	
	100	100

The following table shows the income and outgo of nitrogen and carbon and was obtained by Atwater in one of his respiration experiments, from a man on ordinary mixed diet:

CALCULATION OF ENERGY METABOLISM FROM CARBON AND NITROGEN BALANCE. MAN OF 64 KILOGRAMS AT REST IN ATWATER RESPIRATION APPARATUS

	Income: Grams per Day				
	Protein	Fat	Carbohydrate	Nitrogen	Carbon
Total in food	94.4	82.5	289.8	15.1	239.0
Lost in digestion	5.4	3.7	3.2	0.9	7.4
Absorbed	89.0	78.8	286.6	14.2	231.6

	Outgo	
By lungs	....	207.3
By kidneys	16.2	12.2
Metabolized	16.2	219.5
Balance	−2.0	+12.1

The above experiment shows a loss of 2.0 grams of body nitrogen plus the factor x 6.25 equals 12.5 grams of body nitrogen consumed. The intake of nitrogen was 89.0 grams from foodstuffs absorbed, and in all there

were burned 101.5 grams of protein. The respiratory quotient in this experiment at the commencement of each experiment day was in equilibrium, therefore the conclusion is drawn that the amount of carbohydrate burned equaled the intake of 286.6 grams per day. Therefore, after making due allowance from this balance sheet of the carbon balance, Sherman(10) estimates the amount of fat burned was as follows:

SHERMAN'S ESTIMATES OF ATWATER'S EXPERIMENT

12.5 grams body protein yield (12.5 x 53 per cent)	6.6	grams carbon
And there were in the absorbed food	231.6	" "
∴ Total available was	238.2	" "
But total catabolized was only	219.5	" "
∴ The body stored in the form of fat	18.7	" "

Since fat contains 76.5 per cent carbon, 1 gram carbon = 1.307 grams fat. ∴ 18.7 grams carbon = 24.4 grams fat.

The body therefore absorbed	78.8	grams fat
stored	24.4	" "
burned	54.4	" "

In all, the body burned per day:

101.5 grams	protein,	yielding	(101.5 x 4.35[1])	442 calories
54.4 "	fat,	"	(54.4 x 9.45[1])	515 "
286.6 "	carbohydrate,	"	(286.6 x 4.1 [1])	1,175 "
TOTAL				2,132 calories

Consumption of Food.—Many suggestions have been advanced in explanation of the increased metabolism following the consumption of food. Mangus Levy(11), Zuntz and others think the increase due to *intestinal* and *glandular work,* that is, to the expenditure required for the enlarged demands upon the muscular system, and for the work of secretion carried out by the numerous glands present in the alimentary canal. Rubner(12) assumes, in addition to the glandular work proper, a specific action on metabolism is produced by the excess of *protein.* He holds that every foodstuff possesses a "specific dynamic" action. He also believes that the protein molecule is decomposed in all cases into a nitrogenous component and a non-nitrogenous component of a carbohydrate nature.

Von Noorden(8) recognizes a specific action of protein nutriment without adapting Rubner's explanation. He asserts that the increased oxidation occurring after the consumption of fats and carbohydrates, as well as that following the ingestion of protein, is due in the main to intestinal and glandular work.

[1] Here the factors for fuel value are not reduced to allow for loss in digestion, because this loss has already been deducted in computing the amount of each nutrient actually absorbed and rendered available.

Fasting.—The effect of fasting on metabolism has been studied in great detail by Atwater and Benedict(13), who were able to determine by means of the respiration calorimeter the heat production of the same (control) man during five-day fasting experiments of one or two days each, and during a four-day experiment with food about sufficient for equilibrium maintenance. They found a total metabolism on fasting days to be 9 per cent lower than on the days when food was taken. Later, Benedict(14) found, after an extensive research, that if the fast was sufficiently prolonged, there would be a decrease in heat production. He conducted an experiment on a man during a seven days' fast, "while the man was living on his own flesh and fat," and found the loss to be: protein, 69.5; fat, 139.6; glycogen, 23 grams per day; total, 1,597 calories. The protein loss equaled 347 grams of flesh; the actual loss of energy measured by the calorimeter was 1.696 per diem, or 100 grams more than the estimated cost. The heat of combustion can be arrived at from the known caloric value of the substances; for example, 1 gram of body protein yields 5.65 calories, and 1 gram of fat, 9.54 calories, and the total when fully oxidized in the human economy would aggregate 1.734 calories.

The Swedish investigator Tigerstedt made a careful study of the carbon and nitrogen balance, the metabolism of a man who abstained from food for five days, following this period with a liberal diet for the next two weeks. The production of heat during the first two days of fasting could not be as definitely determined as in the last three days because of the loss of an unknown quantity of glycogen during the first days.

The following data was obtained, which we take from Sherman and append below:

METABOLIC CARBON AND NITROGEN BALANCE DURING FASTING

	Body weight kilos	Calculated total metabolism, calories	Calories per kilo
First fast day	67.0	2220[1]	32.2[1]
Second " "	65.7	2102[1]	32.0[1]
Third " "	64.9	2024	31.2
Fourth " "	64.0	1992	31.1
Fifth " "	63.1	1970	31.2
Fed 4141 calories	64.0	2437	38.1
" 4141 " (second day)	65.6	2410	36.8

[1] These figures are slightly too high, because the loss of carbon on these days was due in part to combustion of glycogen, but is calculated as if duq simply to protein and fat.

These tabulated results clearly show that during a period of fasting the metabolism remains fairly constant, notwithstanding the fact that energy is generated at the expense of the tissues. In this experiment 4,141 calories of energy were produced by the food eaten—twice the amount that would have been necessary for mere maintenance. Consequently the work of digestion and assimilation was doubled. It appears then that as a result of fasting the entire metabolism of an individual at rest remains fairly constant, and the body possesses but little capacity for the adjustment of its energy metabolism to its food supply.

Effect of Nitrogenous Diet on Metabolism.—The effect of nitrogenous diet on metabolism has been studied extensively by von Noorden(8), who holds that the most striking effect of a purely nitrogenous diet is a large increase in the nitrogenous metabolism, but at the same time it also increases the metabolism of the non-nitrogenous elements of the body.

As the amount of protein ingested is increased, a rise in protein metabolism is produced. This sequence occurs to such a degree that nitrogen equilibrium can generally be maintained on the most varied quantities of protein, which goes to prove that the body is not able to store up any excess of protein. At first glance, the fact that the body has the power to break down as much protein as is given to it would not appear to be in accordance with the law that the extent of protein metabolism is governed by the tissue requirements, not by the quantity that is offered to the cells. This law is absolutely true so far as the consumption of oxygen- and nitrogen-free substances is concerned. Usually when there is an increased consumption in protein, there is also a lessened consumption of other foodstuffs, so that with the increased proportion of protein there is a lessened intake of other material. Thus the total energy metabolism is raised, to proportionately a small extent, only when nitrogen-free substances are replaced simply by protein. Perhaps the difficulty of explanation might be made plainer if the hypothesis were found to be correct that the food protein is actually only in small part transformed into true protein within the body, or that it plays the part of protein within the organism only to a small extent.

The statement that the body can consume all protein ingested within a period of twenty-four hours exceeds definite knowledge of the conditions. It is known that the nitrogen and sulphur are eliminated within this period. But whether the carbon that is eliminated during this period is derived from the protein or from other sources, and if from the latter, whether the carbon derived from the protein is stored up in any special form in the body—these are problems yet to be solved.

According to von Noorden's reasoning it is probable that the former is correct, because, as a rule, bodies of small molecular weight, such as amino acids, etc., are completely burned up as soon as decomposition and oxidation have once commenced.

In order to learn how the body attempts to adapt the combustion of protein to its intake, it is well to observe conditions in instances in which different amounts of protein are added to a dietary which is nearly enough for the requirements of the body. If the increase or decrease is not extreme, the nitrogen equilibrium of the organism will not be reëstablished for several days. In the ordinary daily routine when the intake of food varies with the appetite and other influences, the intake and elimination of nitrogen often take place at very short intervals, and so in general, nitrogen equilibrium is kept up on a sufficient diet for long periods. In many instances, individuals during hot weather or when in tropical regions cannot take enough food to supply the needs of the body, and in consequence lose both protein and fat. Von Noorden(8) proved this to be true by experimenting upon himself. He determined that the maintenance of weight was regulated by the fact that the amount of food ingested as governed by the appetite meets on the whole the definite needs of the body. In prolonged experiments on man it has been found that nitrogenous metabolism is not by any means as uniformly maintained on an unvaried protein and caloric intake as is the case in experiments on dogs. Rosemann in one experiment found a daily variation of 10 grams of nitrogen. He points to temporary retention and subsequent washing out of the end-products of nitrogenous metabolism as accounting for these variations. But this explanation has not sufficient foundation.

Atwater and Benedict(15) note the frequent occurrence of similar irregularities. In one of their experiments, variations in nitrogen elimination on a constant diet were 17.2, 17.6, 14.2, 23.8, 20.3, 17.4, 17.2 and 17.4 grams. Psychical conditions were cited as the cause of these variations. The individual in question was so anxious about going into the respiration calorimeter chamber that the mental disturbance brought about a rise in protein metabolism. If, as sometimes happens on the last day of an experiment, protein metabolism is strongly influenced by certain external conditions, the result of the entire series is apt to be markedly affected. This result is naturally exaggerated in shorter series.

Carbohydrates as Protein Sparers.—Carbohydrates as protein sparers have of late received marked attention by research workers on metabolism. It has been observed that, where there is a deficiency of protein in the food supply, the metabolism of nitrogen will be spared and the tissues pro-

tected if the food contains a liberal allowance of carbohydrate and fat. Lusk(16) has fully investigated this subject, and found that, when the aliment contained an abundance of protein, fat and carbohydrate, the organism would gain a little nitrogen; when the ration contained the same amount of protein, *but no carbohydrate,* the body lost nitrogen. On the other hand, when the ordinary dietary contained only a sufficiency of energy, but was of a low protein content, the excretion of nitrogen was normal. Lusk, therefore, concluded that carbohydrate acted as a sparer of protein.

The protein-sparing action of carbohydrates is now well known (editorial, Jour. A. M. A., 1917), and they are by far more efficient protein-sparers than fats. "The starvation output of nitrogenous waste products, especially urea, can be materially lessened by the ingestion of either fats or carbohydrates, though the superiority of the latter non-nitrogenous foodstuffs in lessening nitrogen waste is always greater. If the carbohydrates are omitted from the dietary or even replaced by fats, the effect on the amount of nitrogen excreted is promptly perceptible.

"Various theories have been proposed to explain this unique function of the carbohydrates in nutrition. One view has maintained that a certain concentration of blood sugar is always necessary for proper maintenance of physiological activities. This sugar can be produced from proteins if carbohydrates are not directly available, and since, in the absence of carbohydrates, under physiologic conditions, fat cannot well supply this want, proteins are broken down to yield the sugar that is lacking. The result is an increase in the nitrogen output in carbohydrate starvation."

Another view lately championed by Cathcart(17), of Glasgow, and Janney(18), of New York, postulates that carbohydrate is essential to protein synthesis. "There is no doubt at present that sugar is not oxidized directly in the metabolism of the organism, but is rather dissociated in a definite way into simpler derivations, of which methyl glyoxal, $CH._3CH.CHO$, lactic acid, $CH_3CHOH.COOH$, and pyruvic acid, $CH_3CO.COOH$, are the most interesting possibilities. There is evidence that these compounds derived from sugars can in turn be converted into sugar in the diabetic individual. They may, accordingly, be concerned in the synthesis as well as the disintegration of the sugar molecule. But there is also some evidence now available, largely from perfusion experiments on surviving isolated organs, that both pyruvic and lactic acids can be converted into the amino-acid alanin; that is, they can add nitrogen under conditions approximating physiologic possibilities."

Kocher(19) has recently reminded us that, if this process of retaining

nitrogen by dissociation products of sugar to form new amino-acids, and hence proteins, occurs on a large scale in the body, it will explain why ingestion of carbohydrates spares body protein. To test this point, he has undertaken a comparison of the sparing effects of ingesting lactic and pyruvic acids in contrast with equivalent amounts of undissociated carbohydrates, like sucrose, on the nitrogen output. The outcome of these experiments, conducted at the George W. Hooper Foundation for Medical Research of the University of California (Jour. A. M. A., 1917), indicates that lactic acid exerts practically the same sparing action on protein metabolism as do carbohydrates. "The sparing action of pyruvic acid also is very distinct, but less marked than that following sugar. In view of what has already been mentioned regarding the possibility of adding ammonia to the structures of the sugar derivatives to form alanin, it is readily conceivable that, when this process is operative, nitrogen arising from the catabolism of body proteins, instead of being promptly excreted, is utilized to synthetize new protein. This is not a new conception of metabolism; but Kocher's work gives added support to the possibility that the fixing of catabolized nitrogen by the dissociation products of glucose to form new proteins is the true mechanism of the sparing effects of feeding carbohydrates on the nitrogen output."

Fat versus Carbohydrates as Protein Sparers.—The subject of fats *versus* carbohydrates as protein sparers has been studied exclusively by Kayser and Landergren(20). They believe that fat quite as well as the carbohydrates protects protein not only in nitrogen hunger but in nitrogen abundance. According to Landergren, in certain instances, fat alone as compared with carbohydrates seemed to exert half the protective power of the latter as a protein sparer. This he attempted to substantiate on the ground of the demand of the body for carbohydrates; and that when deprived of this food element, the glycogen formed in the tissues from protein is accepted as a substitute for combustion. The rôle of protein in this process cannot be taken by fat. It follows that as soon as the supply of glycogen in the body is exhausted, fat has less protective power than carbohydrate as a protein sparer.

Atwater(21) concluded from his experiments that the total available energy remaining uniform, protein protection by carbohydrates (largely cane sugar) is slightly superior to an isodynamic amount of fat; this fact may possibly be due to the "personal equation" of the control.

Kayser(22), in a series of experiments, compared the efficiency of carbohydrates and fats as sparers of protein by carefully determining the nitrogen balance and substituting the carbohydrates of the ration by an

amount of fat which would furnish the same fuel value in calories. The control who served as his subject for this experiment was a man 23 years old, of good physique, weighing 67 kilograms, with a small store of body fat. During the first and third periods of observation, his alimentation consisted of meat, rice, butter, eggs, sugar, oil, vinegar and salad. During the second period, his dietary consisted of meat, eggs, oil, vinegar and salad, all of the carbohydrates being practically withdrawn and replaced by fat. The two rations had practically the same fuel value and protein percentages. The results of this study are tabulated below:

KAYSER'S TABLE SHOWING NITROGEN BALANCE WHEN FEEDING ISODYNAMIC QUANTITIES OF CARBOHYDRATE AND FAT

Day	Intake				Output, Total Nitrogen	Nitrogen Balance
	Total Nitrogen	Fat	Carbo-hydrates	Fuel Value		
	Grams	Grams	Grams	Grams	Grams	Grams
1	21.15	71.1	338.2	2590	18.66	2.46
2	21.15	71.8	338.2	2596	20.04	1.11
3	21.15	71.8	338.2	2596	20.59	0.56
4	21.31	71.8	338.2	2600	21.31	0.00
5	21.51	221.1	0	2607	23.28	1.77
6	21.55	217.0	0	2570	24.03	2.48
7	21.55	215.5	0	2556	26.53	4.98
8	21.10	70.4	338.2	2581	21.65	0.55
9	21.10	70.4	338.2	2581	19.20	1.89
10	21.10	70.4	338.2	2581	19.65	1.45

On carefully examining this table it will be seen from the nitrogen balance of the first period that the amount of protein in the food was more abundant than was necessary; however, the nitrogen equilibrium was established on the fourth day. When fat was substituted for carbohydrate, there was a marked increase in protein catabolism with corresponding loss of nitrogen from the body. On the other hand, the loss of nitrogen increased daily while the fat diet was continued, but, upon resuming the mixed diet, not only was the loss of protein stopped, but the body immediately began replacing the protein it had lost, although the nitrogen and the calories of the food remained practically the same.

Kayser found that "the nitrogen intake remaining constant, the substitution of isodynamic amounts of fat for all the carbohydrates of the diet resulted within three days in a total loss of 9.2 grams of nitrogen. The loss on the first day was 1.77; on the second day, 2.48; and on the third day, 4.98, while during the periods before and after, one gram of

nitrogen daily was retained. Landergren, who holds that the variation between carbohydrates and fats as protein sparers is not dependent upon the difference in their physical and chemical properties, advances the following explanation as a possible solution of the problem. If there are no disposable carbohydrates present, either in the food or in the storehouse of the body, then the organism must itself produce carbohydrate in order to satisfy its requirements. As, according to this investigator, a formation of sugar from protein may take place, but never one from fat (at least, under physiological conditions), then, in the absence of carbohydrate, a certain additional amount of protein must break down, in order to furnish the necessary carbohydrate requirements of the organism." This investigator finds the absolute daily carbohydrate requirement of the adult to be 40 to 50 grams. In his opinion, 30 to 40 grams of protein will be sufficient to furnish this amount if no preformed carbohydrates are present.

Atwater(23), in one of his researches, compared the protein-sparing power of carbohydrate and fat in an experiment in which his subject was an athletic young man weighing 67 kilograms, who was accustomed to perform a considerable amount of work. The fifteen-day experiment was conducted in the respiration calorimeter, and the subsistence, rich in carbohydrates, was arranged in four periods which were alternated with four equal periods in which the diet was rich in fat. The change from carbohydrate to fat and *vice versa* involved about 2,000 calories or nearly half the fuel value of the diet. The average results per day for this experiment were tabulated as follows:

SPARING POWER OF CARBOHYDRATES AND FAT IN CALORIMETRIC EXPERIMENTS (ATWATER)

	On Diet Rich in Carbohydrates	On Diet Rich in Fat
Available calories in food	4532	4524
Heat equivalent of work performed, calories	558	554
Nitrogen in food, grams	17.5	17.1
" " feces, "	2.5	1.7
" " urine, "	16.6	18.1
" balance, "	−1.6	−2.7

The difference here is in favor of the carbohydrate, but this is so small as to be of no practical significance.

It appears that the carbohydrates of the dietary cannot be entirely

replaced by an equal number of calories in the form of fat without jeopardizing the nitrogen balance.

Gelatin as a Protein Sparer.—Gelatin as a protein sparer has been studied extensively by Voit, Wilcock, Hopkins, Kauffmann, Kolpakcha and others. According to Voit(24), it would seem that the high nitrogen content of gelatin and the fact that it is soluble led to a tendency to attribute to it an unusual nutritive value. The fact, too, that gelatin could be obtained from bones, which otherwise were burned or thrown away, was important in suggesting it as a means for the economical feeding of the poor. The history of gelatin as a food is very interesting, and indeed instructive, since it serves as a warning against a premature application of the results of scientific investigation.

A committee of the Paris Academy of Medicine investigated gelatin as a food and recommended it as a most nutritious and healthful foodstuff when its natural insipidity was corrected by the addition of salts and savory herbs. On the basis of this report, gelatin was generally used in the nourishment of hospital patients, but in the course of time, complaints were made and doubt raised as to its real food value. The true value of gelatin as a food, as we understand it to-day, was established by Voit's experiments, still it is evident that something remains to be explained. It is not clear why it cannot be better borne in a diet when used in larger quantities. Wilcock and Hopkins(25), after an extended study of this subject, conclude that the special protein-sparing properties of gelatin are due largely to the abundance of glycocoll in its composition, and aver that it shares with protein certain molecular groupings necessary to satisfy specific needs and is thus superior to fats and carbohydrate as a protein sparer. It lacks, on the other hand, certain necessary groupings, therefore failing to supply all such needs, and thus cannot replace protein. It is a well-known fact that gelatin as a sole protein food does not suffice for the maintenance of nitrogen equilibrium. Recent study of protein chemistry has shown that gelatin differs from most other proteins in yielding on hydrolysis no tyrosin nor tryptophan and little if any cystin.

Kauffmann(26) personally experimented with a diet in which these three amino-acids were ingested along with gelatin to the exclusion of other protein, and found that nitrogen equilibrium was maintained throughout the entire five days' fast on this aliment. Von Noorden(8), after many qualitative analyses of gelatin, is certain that it contains much glycocoll and very little leucin and aromatic amino-acids. He believes the variable composition of gelatin is but one of the reasons why it is so ill adapted for the building up of protein. He arrives at this conclusion

after an experiment, and says a considerable quantity of gelatin in the food effects the economy from 20 to 30 per cent in the protein decomposition of starvation, but quantities three or four times as great increase the economy to only 40 per cent instead of trebling or quadrupling it as might be expected. The loss of body protein cannot be prevented by adding much non-nitrogenous food to even the largest gelatin diets. A few years ago there was prevalent a popular idea that jelly was strengthening. Physicians concluded this to be erroneous and averred that jelly was of no use. Both were wrong. Gelatin undergoes catabolism, being changed into urea, and is a protector of protein, not by lessening the amount of material oxidized in the same way as carbohydrate and fat, but by being directly substituted for the nitrogenous elements of the body. The addition of gelatin to the dietary aids in establishing nitrogenous equilibrium on a smaller amount of protein than when gelatin is withheld, and even the consumption of fat is lessened by the allowance of gelatin in the aliment. This is all the plainer when we consider that gelatin in the process of catabolism is split into a urea moiety and a fatty moiety, like proteins. The important point in this connection is that gelatin, alone or with carbohydrates or fats, does not suffice to maintain the nitrogen equilibrium. It does not supply the nitrogenous material requisite for the repair of tissue. This deficiency is explained by the fact that in the composition of gelatin certain important amino-acids are lacking—tryptophan, tyrosin and cystin.

Howell(27) states that "if a dog is fed upon a diet in which the nitrogenous material is represented only by the split products of a gelatin hydrolysis, he will show a nitrogen loss. If the above named amino-acids are added, particularly the tryptophan, he will be maintained in nitrogen equilibrium. It is at present conceded that gelatin takes the place of stored or circulating protein, but not of tissue proteins, and therefore it will be seen that it does not serve the purpose of replacing the wear and tear of tissue." Nevertheless, gelatin is a more valuable foodstuff than it was formerly considered to be.

Alcohol as a Protein Sparer.—"Alcohol as a protein sparer has been the subject of much discussion among physiologists. It would be impossible to summarize the evidence on each side of the question here, but, in brief, the results of the latest and most trustworthy researches show that alcohol undoubtedly possesses a limited power in restricting nitrogenous waste." Alcohol is unquestionably a fat-sparer, though with greater difficulty is it able to spare carbohydrate. But while sparing fat, and sometimes carbohydrates, it is itself consumed—yielding heat and energy to the

body. This was once a mooted point with physiologists, but there is no longer any doubt that alcohol is a food, but a very expensive food. Careful research has shown that the complete combustion of one gram of alcohol in the body will yield 7 calories of heat energy; so that 131 grams of alcohol will yield as much fuel to the body as 100 grams of fat, which means that one ounce of alcohol is equal in energy or fuel value to one ounce of butter (80 per cent fat). While this statement is a recorded fact, we do not intend to convey the idea that we hold that alcohol is as good a source of energy in the diet as fat. Quite the contrary is the case, for, as we have already seen (*see* Volume I, Chapter XVI, page 578), by dilating the blood vessels alcohol may cause more heat dissipation than it is itself capable of producing.

Besides, the energy which alcohol yields is very quickly dissipated, owing to the rapid oxidation of alcohol in the body, while fat produces energy in a slower and more equable fashion.

Hutchison(28) thinks that larger doses of alcohol cause a general paralysis of cellular activity, so great that heat production is diminished and heat loss increased, with the final result of great lowering of the body temperature. If it be granted, for sake of argument, that alcohol is oxidized in the tissues with the liberation of energy, any value which it may possess in virtue of such metabolic action is seriously counterbalanced by its paralyzing and anesthetizing action on cellular activity. This causes the cells, for the time being, to lose their power of breaking down those compounds, such as fat, which it has, even under normal conditions of full activity, most difficulty in handling. Moreover, this dulling of the senses and inhibition of cellular activity is quite in accord with our present understanding of the effects of other cell poisons; and this knowledge should be accepted as Nature's warning, for, as experience has shown, the consumption of alcohol during muscular work augments rather than delays fatigue(29).

Furthermore, as previously stated, it is believed that to a limited extent alcohol may lessen nitrogenous waste; however, its action in this respect is much less than that of carbohydrates, and less even than that of fats, and in addition there seems to exist some subtle influence of conditions not clearly understood, which depend, in certain instances (at least to some extent), upon personal peculiarities of the subject.

Habit, also, undoubtedly is an important factor(30), as, with those who are accustomed to alcohol, the initial loss in nitrogen is less marked than in the case of total abstainers. In the case of fever patients who have been previously accustomed to the consumption of alcohol, even large

quantities do not give rise to nitrogen losses. Practically all physiologists agree that alcohol spares less protein than do carbohydrates when both are given in isodynamic quantities, but in practical therapeutics this is really of little importance. The physician does not desire to make use of the protein-sparing properties of alcohol, but instead he does endeavor by its use to spare the fat of the organism.

In the experiments of Atwater and Benedict(31) it was found that the utilization of the different foodstuffs was not affected by the administration of alcohol, as shown in the following table:

UTILIZATION OF DIFFERENT FOODSTUFFS WITH AND WITHOUT ALCOHOL

	Protein	Fat	Carbohydrates	Energy
With alcohol......	93.7	94.6	97.8	92.1
Without alcohol...	92.6	94.6	97.9	91.8

This tabulation shows the extent to which the food material was metabolized when alcohol was administered.

It has been held by some observers that the administration of alcohol exerted a favorable action in retarding tissue waste which accompanies prolonged pyrexia, but unless its metabolic action is very different in fever from its action under normal healthy conditions, and there seems to be *little* affirmative evidence, we are not justified in granting it any such favorable action.

Finally, in summing up the influence of alcohol on metabolism, we are safe in concluding that it is burnt up in the body, sparing fat and carbohydrates, and, to a very limited extent, it may spare protein, but the weight of evidence is against the conclusion that it exerts any important action tending to inhibit nitrogenous waste(32).

Metabolism of Water.—The metabolism of water in the human economy has been worked over by many serious investigators. Bischoff, Foster and Hennenberg held that the "flushing" of the system with water hastened the breaking down of protein substances. Voit(24), in particular, was the first to make any trustworthy experiments upon this question. He found that the rise in the excretion of nitrogen was 25 per cent, with an increase of the total urinary sulphur compounds from the tissues, and in any case it falls far short of the amount of the increase of the nitrogen excretion(33).

Bidder, Schmidt, Murck and Meyer(34), on the other hand, believe that the urinary nitrogen increases because the tissues are more thor-

oughly flushed or washed out and thereby lose their nitrogenous end-products.

The human body consists of 630 parts per 1,000 of water, and it is of the greatest importance as a component of the tissues to assist in the exchange of nutritive substances, the discharge of the products of metabolism, the regulation of temperature and other vital functions. If the supply of water be cut off, the body will die, and it will succumb sooner from deprivation of water than by starvation. A restriction of the water supply consumed hastens the decomposition of protein and fat to replace the water essential for the body functions.

Atwater and Benedict, as a result of a 49-day experiment with a control in repose, showed that the average income of water was 2,290 c.c. and the excretion 3,700 c.c., so that at the lowest estimate about 250 c.c. of water was formed in the tissues by the oxidation of hydrogen in the food, while in the tissues and during ordinary work they found that from 510 c.c. to 540 c.c. of water was excreted daily in excess of the amount consumed in the food and drink. The amount of water ingested with food and drink varies according to position, life, habits and environments of the individual, but the above figures give a fair idea of the amounts of water taken with a mixed diet under comfortable circumstances(17).

Von Noorden holds that, in addition to the fluid drunk, the body has at its disposal the "oxidation water," resulting from the combustion of the hydrogen of the food. The amount of this varies but little, depending less upon the nature of the food oxidized than upon its quantity, in other words, upon the absolute extent of metabolism.

The following table graphically emphasizes this point:

"OXIDATION WATER" RESULTING FROM THE COMBUSTION OF HYDROGEN IN THE FOOD

Foods	Contains grams H	Contains grams H_2O	Yields calories	100 calories yields grams H_2O	
100 grams fat	11.9	107.1	9,461	11.3	
100 " starch	6.78	55.5	4,181	13.3	11.3
100 " protein	4.59	41.3	4,442	9.3	
100 " alcohol	13.4	117.4	6,981	16.6	

A careful study of the above tabulation shows that, for each 100 calories developed, the ternary food elements produce approximately the same amounts of water, 11.3 grams. On a mixed dietary, where fifty per cent of the potential energy is derived from the carbohydrates and

one-sixth from the protein, and the remaining from the fat, each 100 calories correspond to about 12 grams of water, so that we have:

From....	2,000	2,500	3,000	4,000 calories
About....	240	300	360	420 "oxidation" water

The approximate figures from von Noorden, just given, agree fairly well with the quantities determined experimentally by Voit, which were as follows:

During starvation..........	32 gm. H equals 288 H_2O, with an exchange of about 2,300 calories.
With average diet and light work..................	40 gm. H. equals 360 H_2O, with an exchange of about 2,600 to 2,800 calories.
With hard work............	52 gm. H. equals 468 H_2O, with an exchange of about 3,600 calories.

Atwater and Benedict(35) observed that:

During rest................	30 gm. H equals 270 H_2O, with an exchange of about 2,209 calories.
During hard work..........	50 gm. H equals 451 H_2O, with an exchange of about 3,630 calories.

Neumann(36) conducted an ideal experiment upon himself, subsisting upon a regular and constant dietary, the chief results of which are tabulated below:

NEUMANN'S DIETARY EXPERIMENT

	H_2O in drinks	Nitrogen Balance									Total for Entire Period
		Day									
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	
1	970	+0.42	+0.19	+0.16	−0.06	......	......	......	......	......	+0.4
2	3,000–3,900	−3.8	−2.4	−0.1	......	......	......	......	......	......	−6.3
3	600– 900	+3.35	+1.92	+0.78	......	......	......	......	......	......	+6.1
4	3,100–3,700	−3.16	−1.51	+0.59	+0.51	−0.23	+0.19	+0.59	+1.0	+1.23	−0.89
5	700–1,700	+2.91	+0.72	+0.42	+0.88	......	......	......	......	......	4.9

In studying this table it will be seen that his consumption of water increased from 970 c.c. the first day of first period to 3,900 c.c. the last day of the second period and 3,700 c.c. the last day of the fourth period.

The urinary nitrogen was increased during only the first two days. On and after the fourth day he remained in nitrogenous equilibrium, although he continued to drink abnormally large quantities of water. During this experiment Neumann was punctiliously careful as to details and noted when he returned to the small consumption of water, as in the third period, or after he had flushed out his system for a long period, as in the fourth period, that his initial loss of nitrogen was fully compensated by the retention of corresponding amounts of nitrogenous substances.

Von Noorden, in commenting upon this experiment, emphasizes the facts as tabulated, and says: "For the adult healthy man the question has been answered once for all." It will be seen, therefore, that "flushing out" the system removes the end-products of nitrogenous metabolism *without any abnormal breaking up of protein.*

In summing up the results of Neumann's experiment, von Noorden concludes as follows:

The amount first washed out and then retained was about six grams of nitrogen. One might be tempted to regard this quantity as the maximum "excess of extractives loosely retained in the system," and to base other calculations upon it as such in other investigations of the metabolism. Were this justifiable, one would be able to set down any further excess of nitrogen lost with some certainty to the decomposition of protein. But this view is not justifiable, since such consumption of water produces no more than a mechanical flushing of the tissues. Under different circumstances, it is quite possible that perhaps amounts of extractives might leave the tissues; yet it is most important that conclusions drawn from the action of the healthy body should not be applied to diseased tissues. And there is one thing that these experiments bring out very clearly, and that is the tenacity with which the organism holds on to its extractives. With but few exceptions, these bodies should not be regarded as the valueless decomposition products destined for excretion only. They must rather have definite functions—of which we know nothing for the most part—to perform in the economy of the body.

Metabolism of Mineral Substances.—The metabolism of mineral substances, from a strictly chemical viewpoint, is of small moment, since they undergo only minor chemical changes, and play even a less important rôle in the transformation of energy; they *are not* sources of energy and it is questionable even if they have any part in its development. Indeed, their exact significance in the organism is only partially understood, but at the same time it is a well-known physiological fact that life cannot be supported on foods deficient in inorganic salts. Beyond question they serve most important functions in maintaining a normal composition and osmotic pressure in the fluids of the body, and, by virtue of their osmotic pressure, they play an important part in the ingress and egress of water to and from the tissues. Besides, the inorganic salts constitute an essential part of the composition of all living matter.

Howell says:

In some way they are bound up in the structure of the living molecule and are necessary to its normal reactions or irritability. Even the proteins of the body liquids contain definite amounts of ash, and if this ash is removed, their properties are seriously altered, as is shown by the fact that ash-free native proteins lose their property of coagulation by heat. The globulins are precipitated from their

solutions when the salts are removed. The special importance of the calcium salts in the coagulation of blood and the curdling of milk has been referred to, as also the peculiar part played by the calcium, potassium and sodium salts in the rhythmical contractions of heart muscle, the irritability of muscular and nervous tissues, and the permeability of the capillary wall and other membranes. The special importance of the iron salts for the production of hemoglobin is also evident without comment. There can be no doubt, in fact, that each one of the salts of the body has a special nutritive value and a special metabolic history. The time will doubtless come when the special importance of the potassium, sodium, calcium and magnesium will be understood as well, at least, as we now understand the significance of iron, and quite possibly this knowledge will find a direct therapeutic application, as in the case of iron.

In the human body the mineral salts exist partly in combination with organic substances and partly in solution in the body fluids. Inorganic substances, when burned with access of air, set free the mineral substances which exist therein; likewise, when foodstuffs containing the inorganic salts are metabolized in the body, they are (with the exception of iron) given off chiefly in the form of mineral matter. These elements and their compounds are therefore usually referred to as ash constituents, and their metabolism as mineral metabolism.

The table given below shows the most important of the inorganic salts and the percentage found in bone, muscle and the various organs of the body. The inorganic salts found in the body are either eliminated from the body by the urine and other excretions, or they may be retained and recombined with freshly absorbed organic substances from the alimentary canal.

THE PERCENTAGE OF ASH IN BONES, MUSCLES, AND VARIOUS ORGANS

	Bone (Heintz)	Muscle (Staffel)	Liver (Oidtmann)	Spleen (Oidtmann)	Brain (Breed)	Blood (Verdell)	Lymph (Dahnhardt)	Milk (Wilderstein)
Sodium chlorid..	.....	10.59	.....	.....	4.74	58.81	74.48	10.73
Potassium chlorid	.....	.....	.....	.....	.....	.....	.....	26.33
Soda...........	.....	2.35	14.53	44.33	10.69	4.15	10.35	.....
Potash.........	.....	34.40	25.23	9.60	34.42	11.97	3.25	21.44
Lime...........	37.58	1.99	3.61	7.48	.72	1.76	.97	18.78
Magnesia.......	1.22	1.45	.20	.49	1.23	1.12	.26	.87
Ferric oxid......	.....	.....	2.74	7.28	.....	8.37	.05	.10
Chlorin.........	.....	.....	2.58	.54	.....	.....	.....	.....
Fluorin.........	1.66	.....	.....	.....	.....	.....	.....	.....
Phosphoric acid..	53.31	48.13	50.18	27.10	50.18	10.23	1.09	19.00
Sulphuric acid...	.....	.....	.92	2.54	.92	1.67	.....	2.64
Carbonic acid....	5.47	.....	.....	.....	.....	1.19	8.20	.....
Silicic acid......	.....	.81	.27	.17	.27	.....	.42	.....

Von Noorden says:

Extract experiments have proven, once for all, the indispensable importance of the inorganic salts to the organism, and the amounts in which they are required during growth has been repeatedly investigated, while only a few serviceable determinations have been made upon the adult.

It is known that the body takes up the organic foodstuffs to supply it with energy, in response to a definite demand. The inorganic material in the food is on a different plane; like water, it is absorbed in excess, or, more plainly speaking, in quantities far surpassing the normal physiological minimum. The requisite amount of the daily decomposition under definite conditions of life and nutrition, calculated on the basis of the urinary salts, is stated by von Noorden(17) in the following approximate figures:

	Gram		Gram
Cl	6–8	Na_2O	4–6
P_2O_5	2–3.5	Fe_2O_3	Traces
SO_3	2–3.5	CaO	0.15–0.35
K_2O	2–3	MgO	0.2–0.3

The physiological minimum intake of inorganic matter has not been extensively investigated. Indeed, its determination is beset with difficulties, since the same differences obtain as in the case of the demand for protein and water, and these depend upon individuality, personal idiosyncrasies and upon variations of the organic constituents of the dietary. It is difficult, therefore, to arrive at a "physiological optimum." This much is certain, a marked decrease in the amount of mineral salts must take place before any impairment of mineral metabolism is noticeable. At any rate, no scientific proof of its importance is available, and beyond question there is an absence of accurate information of the physiological conditions involved.

From the foregoing discussion of mineral metabolism, we learn that the salts of the body are partly bound up with inorganic substances and partly in solution in the body fluids, and are considered as ash. The prevalent custom of speaking of *ash* as a food is incorrect; properly speaking, ash is the term applied to the residue remaining after the incineration of food products in the air at a low temperature, until the carbon has disappeared. Ash is rather an indefinite term and is applied to that residual material of a mineral nature composed of sand or silica and the carbonates or oxids of alkalies or alkaline earths. The ash contains the principal percentage of phosphorus present in food products along with a small portion of sulphur. These bodies exist as phosphoric and sulphuric

acids or their salts. Elements so closely related to chemical properties as sodium, potassium or calcium and magnesium are not only not interchangeable, but in some of their functions are diametrically opposed. Calcium seems to bear a special affinity for, and to exert a favorable influence upon, the efficacy of iron in body metabolism, since it appears to be possible to maintain iron equilibrium upon a smaller amount of this latter element when the ingested food contains an abundance of the calcium salts.

The relative quantities of water, organic matter and inorganic residue (ash) in some of the tissues and body fluids is shown in the following table:

TABLE SHOWING PERCENTAGE OF WATER, ORGANIC MATTER AND INORGANIC RESIDUE (ASH) PRESENT IN CERTAIN TISSUES AND BODY FLUIDS

	Water	Organic and volatile matter	Inorganic residue (ash)
Blood corpuscles	54.60	44.68	0.72
Blood serum	90.50	8.68	0.82
Urine	95.70	3.00	1.30
Bone	22.10	26.00	52.00
Dentine	10.00	25.00	65.00
Enamel	0.40	3.60	96.00
Blood	79.50	19.75	0.80
Human milk	86.80	12.85	0.35
Pus	87.00	12.20	0.80
Lymph	91.80	7.40	0.80
Chyle	91.80	7.40	0.80
Bile	85.92	13.30	0.78
Pancreatic juice	90.97	8.18	0.85
Gastric juice	99.43	0.33	0.24
Saliva	99.50	0.32	0.18

Acid-forming and Base-forming Elements.—The *acid*-forming and *base*-forming elements of the aliment are interesting from a clinical point of view. For example, a dietary of proteins, fats and carbohydrates which has been demineralized and leaves no ash residue after incineration, will introduce no fixed bases in the body, but, on the other hand, will introduce sulphuric acid from the metabolism of sulphur contained in the ingested protein. Such a dietary would be "acid-forming."

Doctor Taylor(37), of the University of California, subsisted for a period of nine days upon a practically ash-free aliment made up of 70–75 grams of purified egg albumin, 120 grams of washed olive oil, and 200 grams of cane sugar. He describes his symptoms as essentially those of

acidosis, similar to that produced from the want of base-forming elements in the diet. Later Goodall and Joslin(38) carried out experiments similar to Taylor's without obtaining confirmatory evidence, which would suggest considerable differences between persons in reference to susceptibility of the acids elaborated in the metabolic processes.

Deprivation of the organic acids leads to a peculiar disturbance of the system resulting in the development of scurvy. Of the inorganic salts sulphur is essential to growth. The chlorids keep the globulins in solution, and are the source of the hydrochloric acid of the gastric juice. The phosphates are essential for the growth of bone and to the nervous system. Deficiency of calcium and magnesium leads to *rickets* and other abnormal conditions.

Gout has been termed the disease of luxury. On the other hand, scurvy is the disease of privation or penury. Funk and other writers hold that scurvy is a deficiency disease due to lack of vitamines in the foodstuffs. Gautier held that the class of vegetables containing a liberal amount of alkaline ash acts as an antiscorbutic.

Sherman(39) avers that:

> If susceptibility to scurvy and the injurious results from an ash-free diet are even partly due to the disturbances of the balance of acid-forming and base-forming elements in the food, it would seem to follow that the normal dietary should be so chosen as to furnish the body enough base-forming elements to neutralize the mineral acids produced in metabolism.

This author determines the *balance* of acid-forming and base-forming elements in foodstuffs by ascertaining the presence of chlorin, sulphur, phosphorus, sodium, potassium, calcium and magnesium, computing the equivalent in acid of the first three elements, the equivalent in alkali of the last four, then determining the excess of *acid* or *base,* as the case may be, which would result from the complete oxidation in the blood. He holds that:

> While in actual metabolism all of the sulphur of the food is not oxidized to sulphate and the ammonia is not quite all converted into urea, yet the method is fairly satisfactory as a means of comparing foodstuffs in respect to their metabolic acid-forming and base-forming properties.

For tables graphically showing the relative preponderance of acid-forming and base-forming elements in some typical foodstuffs, as worked out by Sherman, consult the following (Volume II, Chapter XI, page 357).

From a study of these tables, it will be learned that lean beef and round steak, bacon and ham possess a high percentage of acid-forming elements. It will also be seen that the cereal grains show a slight prepor-

derance of the acid-forming elements. While, in the second table, it will be seen that milk, fruits and vegetables show an excess of base-forming elements.

The blood is physiologically and chemically an alkaline medium and upon its alkalinity depends its power of transporting carbonic acid, and upon this fact as well depends the power of the blood to take up, at certain times, organic acids without itself becoming acid. When large doses of alkalies are administered, the economy at once begins preparing for their excretion, so that a short while after absorption only a small portion can be found present in the organism.

Just how alkali is retained in the blood, how much of it at any stated period is present in the blood and lymph, what quantities pass into the different tissues and various organs, is not definitely known. And yet an accurate understanding of this interesting phenomenon would be of great practical significance for the scientific medical man. The great variation in the alkalinity of the tissues, though often challenged by therapeutics, is at present an admitted fact Still their percentage and extent are as yet "seen through a glass darkly."

A dietary in which the acid-forming elements are present in excess calls for a withdrawal of the fixed alkalies from the tissues and circulating fluid on the one hand, or, on the other, for an increase of ammonia salts in the body, neither of which is desirable. Carnivorous animals habitually ingest foods with an excess of acid-forming elements without harmful effects, and while in man it might not be dangerous, yet it must put an extra tax upon a constitution accustomed to a mixed dietary which might better be avoided, especially, as Sherman thinks:

> We have no reason to anticipate any disadvantages from a preponderance of base-forming elements, which, if not used to neutralize stronger acids, would take the form of bicarbonates and thus aid in the maintenance of the normal and necessary neutrality or faint alkalescence of the blood and tissues. It would be a good practice, therefore, when formulating a dietary in which the foods contain acid-forming elements, to be fairly well balanced by other foods in which the base-forming elements predominate, so that the diet as a whole may yield sufficient fixed bases to neutralize any excess of mineral acids evolved during the processes of metabolism.

If all the available information could be collected, with the opinions of critics added thereto, it would make a volume in itself. Therefore, we present only a brief prologue to mineral metabolism and the reader is referred to the succeeding chapter for value uses and sitology of the inorganic salts.

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CHAPTER XI

SCIENTIFIC FEEDING OF NITROGEN FOODS

"Man begins to die as soon as he is born," but a competent physician who understands the science of trophotherapy will be able to pilot his patient through the rocks and shoals of diet and land him in a haven of safe and enjoyable life.

Nitrogen in Diet: Nitrogen Equilibrium; Nitrogen in Feces; Low Protein Diet; High Protein Diet; Nitrogen-free Diet.

Protein Metabolism: Urea; Ammonia; Creatinin; Uric Acid; Purin Bodies —Source, Chemistry, Occurrence in the Body, Purin Bodies in Food, Effect of Purin Foods on Uric Acid, Excess of Purin Diet, Purin-free Diet, Low Purin Diet; Fat-free Diet; Carbohydrate-free Diet; Cellulose Diet.

Mineral Metabolism: Electrolytic Properties of Salts; Sodium Chlorid; Salt-free Diet; Potassium Chlorid; Calcium Diet; Magnesium Salts; Phosphorus; Iron Salts; Sulphur Salts; Acid-forming and Base-forming Elements of Diet; Résumé.

NITROGEN IN DIET

The great attention that food both in health and disease has received in recent years has yielded to the profession of medicine valuable information concerning trophodynamics. We have considered experimental researches in regard to dietetics conducted largely with a view of ascertaining the nutritive value of food material in regard to the requisite quantities for supporting life and maintaining bodily equilibrium in all its phases and activities. We know, too, that the earliest views so ardently promulgated by von Liebig—that there is a direct utilization of particular kinds of food constituents for particular purposes—do not strictly hold true; that the use made of the food constituents in the body is determined not alone by the nature of the constituents, but to a certain extent by the

relative quantities of the various constituents on the one hand and by the particular needs of the body on the other; that, for example, while protein is essential in food for construction of protoplasm, either in growth or repair, when it is ingested in amount greater than is required, the excess is utilized for other purposes—as in oxidation to yield energy or heat, or in storage as glycogen or fat, as the case may be. Indeed, it must be clearly recognized that the knowledge of the food constituents as they enter the body and the end-products of metabolism as they leave the body, yields inadequate information as to the intervening processes of metabolism which may or may not follow along given lines. It is the knowledge that we are to-day gaining of processes of intermediary metabolism, that is shedding new light on phases of nutrition, that heretofore have been merely conjectured or even altogether unknown to us.

For a given individual, exercise governs largely variations in the amount of food required. Within certain limits, it is not so much what form the food is in, so long as it can be utilized. Protein metabolism does not depend so much on the amount of exercise as it does on the amount and proportion of protein food ingested. Nitrogen equilibrium in normally healthy individuals may be maintained on various amounts of protein. It is determined by comparing the total nitrogen intake with the total output. If the amount corresponds, or nearly so, the body is said to be in a state of nitrogen equilibrium. Equilibrium may be established at a low level on partaking of small amounts of protein and larger amounts of non-protein food, or on the other hand, it may be maintained on a high level by partaking more freely of protein with correspondingly less non-protein. Chittenden maintained health, strength and bodily vigor on 50 grams of protein daily. On the other hand, nitrogen equilibrium has been established on as much as 150 to 200 grams of protein daily. The human economy in normal conditions regulates the amount of protein metabolized to both the amount and, as well, the total food ingested.

Nitrogen Equilibrium.—Major Charles E. Woodruff,[1] in discussing the nitrogen equilibrium in the tropics, says:

All natives of the tropics (where civilization causes over-population) are in a condition of nitrogen starvation and need much more nitrogen than they can possibly get. The old standards of teaching that we should eat as the natives is most vicious. They do not eat meat because they cannot get it. They crave it, need it, and eat it when they can. On account of the destructive effects of the concentrated tropical actinic rays on protoplasm, we need more nitrogen than at home. Please do not copy the old falsehood that we need less. It is also true that we

[1] Major Charles E. Woodruff, Surgeon, U. S. Army.

need fat, as it furnishes energy better than carbohydrate. It is eaten in preference to starches and sugars for this purpose by workers when they can afford it, but they take to starch (rice) because it is cheaper. It is incorrect to say that it overheats. It does not overheat us, and it is false to say that fat is not needed in the tropics.

Nitrogen equilibrium is best maintained on a mixed diet, containing in addition to the protein both fat and carbohydrate. If the non-protein portion of the diet is reduced, other things being equal, there will be a nitrogen loss, owing to the fact that more protein is used to supply the heat and energy that formerly was supplied by the greater amount of non-protein food. It takes some days to establish a nitrogen equilibrium when the usual diet of an individual is changed. Say that the ordinary dietary contains 16 grams of nitrogen and the diet is suddenly changed. It will be several days before equilibrium will be established on a new level, whether it be above or below the amount usually metabolized. A slight loss of a transient character will be noted when the intake is lessened, but, if the loss persists, it means that either too little protein is being taken in the food, or that the total caloric value of the food is below the normal amount required, or the body is affected with some wasting disease attended with nitrogen loss.

Nitrogen in Feces.—In determining the available nitrogen in food, attention must be given to the nitrogen of the feces. The feces consist of the undigested residue of the food, together with nitrogen from mucus, worn out epithelial cells from the walls of the alimentary tract, bacteria, coloring matter, bile and other residue. Therefore, the contention that all the nitrogen in the feces is derived from the food is erroneous. That which is derived from the bile, mucus and débris of broken-down epithelial cells is body waste, and has already been added to the nitrogenous content of the organism. During a fast, when no food is consumed, bile and mucus are still secreted, and the epithelial cells continue to break down and bacteria continue to flourish, and are expelled with the feces. Reider conducted experiments with a nitrogen-free food, which he previously ascertained to be readily digestible. The subject was a man of medium height and weight. The ration was a cake made from starch, sugar, fat and a little salt leavened with cream of tartar and bicarbonate of soda. White wine and water in small quantities were the only beverages and were free of nitrogen. This ration was ingested, he believed, in sufficient quantities to secure normal secretion of the digestive juices. On such a diet, the inference is that any nitrogen found in the feces could be attributed to body sources only. The average amount of nitrogen in the feces

during this experiment was 0.5 grams per day, which may be taken to represent fairly the amount of nitrogen in the feces arising from body waste; any amount above this figure ordinarily may be attributed to residue from the food.

Low Protein Diet.—The low protein diet of Chittenden has been referred to above and in Volume II, Chapter V. He and his followers urge but little protein above the minimum, together with the requisite amount of fat and carbohydrates to make up the needed calories. They urge that on this diet health and weight may be maintained and that the mental and physical efficiency is greater than when more liberal diets are allowed.

The experiments of Chittenden are of enormous practical value in showing that a low protein diet can be used for a long period of time without danger (*see* table, Volume II, Chapter IX, p. 254). Low protein diets are of value in gout and all gouty affections, in diseases involving the tegumentary system, more particularly when accompanying disorders of metabolism, in treating the ill effects of habitual overeating and arteriosclerosis, and in fevers and other affections. Brain workers and others following sedentary vocations will no doubt do better on diets lower in protein than usually advised. After carefully considering all the points of a low protein diet, we are led to the conclusion that it is, at the same time, a low-purin diet; and many authorities believe that the beneficial effects are due in part to the freedom of a low-protein diet from *purin bodies*. Many clinicians find there are only a few cases of gout where a moderate quantity of animal food does harm, and many where it exerts a beneficial effect. As a matter of fact, the major portion of the human race will go on eating and drinking and "making merry," according to their appetites and their ability to gratify them. Still, on the other hand, the problem is one of the highest human interest, particularly in reference to the "dietary in disease," and in preventing disease when danger signals loom in the distance. It is interesting to compare the navy diets (*see* Volume II, Chapter XVIII), which are essentially high protein diets, for the reason that the sailor prefers it, and is more contented and does better work than when on perhaps a more healthful protein, but for him less appetizing, diet.

Below we append a standard for a low protein diet:

LOW PROTEIN DIETARY

In the morning upon waking 5 to 10 ounces of hot water containing 10 to 20 grains of sodium bicarbonate or potassium citrate. Half an hour later:

Breakfast:

A large plate of fruit and milk or cream, followed by abundant cereal and milk with bread and butter. No meat, eggs or fish. Wait five hours.

Dinner:

Not more than four ounces of meat or fish, which must be quite fresh; a very large plate of green vegetables, potatoes sparingly, and nothing more than a taste of sweets. Five hours later:

Supper:

May be a repetition of breakfast, but succulent vegetables may replace the fruit, and macaroni or a similar dish may be substituted for the cereal.

Thirst and hunger between meals may be satisfied by water and fruit about one hour before a meal or during the night.

Abstain from meat juices (gravy and soup), gelatin, coffee, tea, cocoa, salt and strong condiments, alcohol, pastry.

All starches and meats must be well cooked.

High Protein Diet.—A high protein diet, according to Voit's standard from 118 to 120 grams of protein daily, may be of use in certain conditions—during pregnancy, lactation, in convalescing from wasting diseases, in the beginning of physical training when muscular growth is great, and in combating certain diseases like tuberculosis, etc. During growth the protein requirements are higher than in adult life, but, on the other hand, high protein diets are objectionable for individuals who follow sedentary occupations, and for all of those conditions benefited by a low protein diet. When studying the subject of Protein and Nutrition in Volume II, Chapter IX, we learned the minimum amount of low-protein diets to be 60 grams, and for a high-protein diet, 120 grams; this leaves rather a wide range, and it is safe to say that the optimum lies between these two. We do not believe that any standard will ever be definitely fixed that will be of universal application, but we are inclined to believe that future standards will be worked out to cover the various classes and normal conditions, as well as in different disturbances of metabolism. To-day the standards that are being put into practical use for tuberculous patients, contain 30 per cent of protein above the normal. In nephritis 60 to 70 grams are allowable; in fevers, 70 grams, etc.

Nitrogen-free Diet.—A nitrogen-free diet can be made from starch, sugar, salt and almond oil or other fat. This material can be made palatable and baked into a cake, with baking powder for leavening. There is no very great therapeutic use for a nitrogen-free diet nor is it conceivable that an individual would be satisfied with it for very long. Its principal use seems to be chiefly for experimental purposes, especially when it is desired to make observations on the metabolism of nitrogen.

Lehman observed that when a man consumed a nitrogen-free diet for a period of three days, he excreted daily 7.4 grams of nitrogen. Reider, in a similar experiment, found that the average excretion of nitrogen by the kidneys was 8.7 grams and the feces contained 0.9 grams, which was equivalent to a loss of 56 grams of protein daily. Physiologists have not yet determined just how much "floating protein," or more correctly amino-acids, there is in the human organism. It varies daily; but it is safe to say that all the floating protein could be consumed in a very few days. If, for any reason, it should be determined to rid the system of "floating protein," it may be done by giving a comparatively free nitrogen aliment for a short period of time. This diet may be selected from the foods given in the table below, showing the percentages of protein in foods:

PERCENTAGES OF PROTEIN IN PROTEIN-POOR FOODS

Foods containing 0.5 per cent or less protein	Foods containing 0.5 to 1.0 per cent protein	Foods containing 1 to 1.5 per cent protein	Foods containing more than 2 per cent protein
Arrowroot starch, cornstarch, sugar, honey, cottonseed oil, almond oil.	Manioc starch, arrowroot, sago, tapioca, apples, pears, plums, rhubarb, tomatoes, cucumbers, radishes, turnips, oranges, lemons, raspberries, gooseberries, strawberries.	Grapes, bananas, leeks, onions, cabbage, celery, squash, parsnips, cauliflower, sauerkraut, horseradish, tomato catsup, butter.	Potatoes, string beans, artichokes, lard, thick cream, fat salt pork, fat ham, bone marrow.

After taking a diet consisting of the foregoing fruits and vegetables for four days, some bread, rice, oatmeal, milk pudding or soup may be added to the list. The amount of protein in these foods is as follows: Beef soup, .4 per cent; meat stew (when meat is taken out), 4.6; oxtail soup, 4.0; chicken broth, 3.6; tomato soup, 1.8; vegetable soup, 2.8; milk, 3.5; boiled rice, 2.8; boiled oatmeal (thick), 2.8; brown bread, 5.5; white bread, 8 or 9; zwieback, 9.8 per cent. The return to the ordinary diet, or one containing at least 55 grams of protein daily, should not be deferred longer than the eighth day.

Spirits contain no protein. The amount in wine is practically negligible, and an infusion of cereal coffee (1 in 20) contains only 0.2 per cent

of protein. The choice of foods is large, and such a diet, while yielding sufficient energy, would speedily result in a clearance of superfluous protein materials.

We have learned that cell metabolism is attended by changes of a destructive nature. Carbon is oxidized, yielding carbon dioxid; hydrogen unites with oxygen and forms water. Nitrogen is burned off, but only partially reduced, urea being the chief product of protein metabolism. It is formed largely in the liver, but it is very probable that other cellular organs, such as the spleen and lymphatic glands, participate in its formation.

PROTEIN METABOLISM

In the study of the Physiology of Enzymes and Hormones as Applied in the Process of Digestion (Volume I, Chapter VI), we learned that the protein molecules, on being metabolized in the body, yield varying amounts of arginin, which ultimately undergoes hydrolysis into ornithin and urea. In this way it is possible to trace an appreciable part of the nitrogen of protein to the urea stage through a series of direct cleavages. The protein in digestion and in catabolism is split into amino-acids, which are eventually deaminized, the nitrogen of the amino-group being split off as ammonia. This, with carbonic acid, forms ammonium carbonate or carbamate which is transformed into urea by various organs of the body, notably by the liver, as stated above.

The important nitrogenous end-products of protein metabolism other than urea, are ammonium salts, purin bodies and creatinin.

Urea.—Protein metabolism has heretofore been considered to be qualitatively better, in proportion as a larger percentage of the urinary nitrogen is eliminated as urea and a smaller moiety in other forms. This, however, is not always the case, since this may be largely a matter of the amounts of protein consumed.

According to Folin, who made a careful and extended study of urines of healthy men partaking first of a high and then of a low protein diet, the distribution of nitrogen betwen urea and other nitrogenous end-products depends very largely upon the absolute amount of nitrogen metabolized. He observed a man who was fed on a high protein diet (free from meat) for one day and at the end of the week was partaking of a diet composed of starch and cream, which furnished in all about 6 grams of protein per day. The end-products of his protein metabolism are shown in the following table from Sherman:

END PRODUCTS OF PROTEIN METABOLISM ON BOTH HIGH AND LOW PROTEIN DIET

Nitrogenous end products of protein digestion	On high protein diet (free from meat)		On low protein diet (starch and cream)	
	Grams	Per cent	Grams	Per cent
Total nitrogen	16.8		3.6	
Urea nitrogen	14.7	87.5	2.2	61.7
Ammonia nitrogen	0.49	3.0	0.42	11.3
Uric acid nitrogen	0.18	1.1	0.09	2.5
Creatinin nitrogen	0.58	3.6	0.60	17.2
Undetermined nitrogen	0.85	4.9	0.27	7.3

An examination of this table shows there was a marked decrease in both the absolute and relative amounts of urea, as well as a decrease in the absolute, but an increase in the relative amount of uric acid excreted, while the absolute amount of creatinin remained stationary.

Regarding the urea of the circulating blood, Dr. Denis, of the Massachusetts Hospital,[1] found that the intake of ordinary protein may be increased from the amount sufficient to give from 6 to 8 grams of urea in the 24-hour urine, to that sufficient to produce a daily urea excretion of from 30 to 50 grams without producing any material increase in the circulating urea. Until recently, we depended entirely upon the analysis of the urine to determine the metabolism of any dietary regimen. The tolerance of the human economy for carbohydrate food was ascertained by examination of the secretion from the kidneys for sugar after an ingestion of varying quantities of this type of foodstuff. The ability of the kidneys to excrete the waste products of inorganic salts was likewise ascertained by urinary analysis and the efficiency of the renal functions was judged on this basis. The more advanced methods for the analysis of very small quantities of blood—so-called micro-analysis—has transformed the seat of observation to the circulating fluid in the vascular system. To-day blood analysis for clinical purposes is making rapid strides, not only so far as qualitative tests are concerned, but for quantitative tests. At the present time, methods for the determination of the sugar content of the blood are in use; likewise, the estimation for non-protein nitrogen, urea, creatinin, uric acid, fats and lipoids has been brought within the scope of a feasible determination on small samples of blood.

[1] Editorial, J. Am. M. Ass., 1917.

Ammonia.—As previously stated, ammonia is evidently a normal precursor of urea, being changed into the latter during its passage through the liver. According to this assumption the elimination of nitrogen as ammonia may be notably increased at the expense of urea: (*a*) by the ingestion of mineral acids, or of food yielding unusual amounts of such acids by oxidation in the body; (*b*) in cases yielding an excess of acids in metabolism, as the acidosis of diabetes, fevers (inanition) and pregnancy; (*c*) in structural diseases of the liver (acute yellow atrophy). It will be seen that the first and second methods increase the ammonia by "fixing" it as salts, thus preventing its transformation into urea, while the third diminishes the ability of the system to effect such transformation.

Creatinin.—Normal urine contains about 1.5 grams of creatinin per day. The origin and significance of endogenous creatinin and especially its physiological relations to creatin (of which it is chemically the anhydrid) is still unsettled, despite much clinical research. It seems to depend on the musculature of the individual. The amount excreted is not governed by the amount of protein consumed, therefore the percentage of urinary nitrogen appearing in this form tends to increase as the total nitrogen diminishes and vice versa. Sherman and Lusk agree with the above statement, but Folin, after an extended study of the urines of healthy men partaking first of a high and then a low protein dietary, concluded that the nitrogen excretion depended largely upon the amount of nitrogen metabolized.

Uric Acid.—The former theory as to the production of uric acid in the body was that it represented protein imperfectly oxidized into urea and that the uric acid diathesis was a condition of suboxidation in which the uric acid acted directly as a toxic agent. Of late, researches of physiological chemists have considerably modified this view, and it is now held that uric acid and allied purin bodies are entirely independent of the general catabolism of protein matter. It is a product of the final stage of catabolism of the purin bodies that in Volume I, Chapter III, we have seen enter into the construction of the nuclein and nucleoproteins. Therefore, the general clinical conception of the uric acid diathesis might be better termed "purinemia," Benedict(1).

Purin Bodies—SOURCE.—Purin bodies are nitrogenous substances constructed on the purin framework, C_5N_4. They include uric acid, xanthin, hypoxanthin, adenin and guanin, and closely related are methylxanthin and theobromin. Fischer has shown the relation of all these bodies to purin. They contain a central chain of three carbon atoms to which is attached on each side a urea group, so that they may be regarded as

diureids. These bodies arise from nucleoprotein, the components of which are normal constituents of the nucleus and protoplasm of cells. In the human economy the nucleoproteins are split into nuclein and protein, and finally the nucleic acid into purin bodies, pyrimidin bases, phosphoric acid and sugars. This is the normal order of the metabolic breakdown of nucleoproteins, and it occurs in some animals as well as in human beings. As a group the purin bodies are said to raise blood pressure and tend to produce angiosclerosis and various sclerotic changes in the viscera.

In studying the characters of the proximate principles of foodstuffs (Volume I, Chapter III), we considered at some length the chemistry of purins and purin compounds, as also the pyrimidin bases to which the reader is referred.

CHEMISTRY.—Although current text-books on dietetics barely mention the chemistry of the individual purins, yet we consider them of sufficient importance to state some of the principal facts which underlie their group reactions in order to delineate the several phases of nuclein metabolism. According to Hall(2), the purin compounds crystallize easily, are more or less soluble in the usual solvents, and can now be oxidized and reduced. Hypoxanthin yields small crystalline scales with sharpened extremities almost like grains of wheat. Xanthin may be distinguished by its thin, flat, glistening rhombic plates, guanin by small prismatic crystals or amorphous masses, adenin by long needle-shaped prisms, and uric acid by rhombic plates. Rarer forms have been demonstrated by variations in the media and rapidity of crystallization.

Their solubilities present the following remarkable differences:

SOLUBILITY OF PURIN COMPOUNDS

Water	Hypoxanthin	Xanthin	Adenin	Uric Acid	Guanin
Cold	1:300	1:13000	1:1086	1:16000	Insoluble
Hot	1:78	1:1300	......	1:1600	"
Alkalies					
Weak	Soluble	Soluble	Soluble	Soluble	Slightly soluble
Acids	"	"	"	Insoluble	Soluble

From a synthetic standpoint the purin bodies are exceedingly interesting. About twelve different derivatives of the purin nucleus are known to exist in nature, but not less than 146 have been produced in the laboratory. The closely related caffein and theobromin are largely used as medicaments for their stimulative and diuretic properties, and it is possible that in the near future these may be made synthetically. Trichlor purin, obtained by the action of phosphorus chlorid upon uric acid, occupies a position midway between uric acid and the methylxanthins, caffein,

theobromin and theophylin. Emil Fischer, in his lucid and interesting address given in Stockholm in November, 1902, after the distribution of the Nobel prize, draws a picture of the time when the present coffee adulterants—chicory and coffee surrogate—will be superseded by synthetically made caffein, and suggests a period when coffee beans and their roasting will be unnecessary, since the solution of a small powder in hot water will give a well flavored, refreshing drink at a much lower cost and with much less trouble than the present conditions necessitate.

OCCURRENCE IN THE BODY.—Purin bodies exist ready formed in many of our foods, especially those in the animal kingdom; but on the other hand, the system can produce its own nuclein and the higher compounds of nuclein on a diet free from purins, though, of course, containing proteins. Further, the elimination of purins is somewhat increased by increasing the intake of proteins, about half of the elimination of purins on an ordinary mixed diet being accounted for by the ingestion of more or less combined purins, and about half by the metabolism of nuclein-containing structures, such as white blood cells and the cells of viscera, namely, the kidneys, liver, pancreas, spleen and thymus. The old theory that no purin bodies are formed except from purins is false, while the older view that uric acid is a precursor of urea is true in a limited sense only. Lusk, referring to the successive steps in purin metabolism, states that deamination is brought about through the action of specific enzymes as follows: "Summarizing these results, it may be said that nucleic acid may be broken up by nuclease, a ferment found in all tissue. On the liberation of the purin bases, guanin and adenin are deaminized by guanase and adenase wherever these enzymes are found. Oxidizing enzymes, the xanthin oxidases, now convert hypoxanthin and xanthin into uric acid, while a uricolytic ferment of varying potency in different tissues in different animals may break up and destroy the uric acid."

Purins occur in both animal and vegetable nitrogenous bodies, in greater abundance in the former and obviously in still greater abundance in glandular viscera and white blood cells than in muscle and connective tissues, on account of the relative preponderance of nuclei, while vegetable nuclein occurs richly in yeast cells. The purins which are consumed with the food are termed *exogenous* purins, and those excreted by a healthy normal individual independent of his food—the result of the metabolism of his own tissues—*endogenous* purins.

The daily "wear and tear" on metabolism of cell constituents leads to the production of a certain amount of purin bodies. These substances constitute the "endogenous" purins of the excreta. When tissues containing

nucleins or free purins are eaten, the "endogenous" purins of the food ingested become "exogenous" to the system which absorbs them. As "endogenous" purins are practically waste products on their way to excretion, when they become "exogenous" to another organism they have little nutritive value and demand early and rapid elimination. This is generally effected by deaminization of guanin and adenin and the oxidation of the oxypurins, hypoxanthin and xanthin to uric acid, and then the purin ring or chain in the uric acid is in the system, probably chiefly in the liver, partially split off and a portion of the uric acid excreted as urea. The course followed in the case of the nucleins is not quite clear, as a smaller percentage appears in the urine as uric acid.

The amount of purins excreted in the urine due to endogenous formation may be estimated after taking a purin-free diet for a few days, and the amount varies from 0.1 to 0.2 grams per day(3). The exogenous purins are principally transformed in the body, 50 per cent being excreted as urea and the remaining portion being eliminated by the kidneys as uric acid with some xanthin and hypoxanthin.

We can apply the term "free-purins" to purin bodies, and "bound-purins" to the purins of nucleic acid, nuclein and nucleoproteins. The process of purin formation goes on throughout life as a part of the cell metabolism, but the transformation of purin, likewise, goes on constantly. A number of enzymes coöperate in the transformation of purin-containing materials, for instance, nucleases liberate guanin and adenin from nucleic acid, these aminopurins being converted by the enzymes guanase and adenase into xanthin and hypoxanthin respectively, and oxidases transform hypoxanthin to xanthin and then to uric acid. The latter is finally to a certain extent decomposed and destroyed by uricolytic enzymes of varying potency present in the various organs.

Hypoxanthin and xanthin are often obtained as products of decomposition of nucleic acid, but are generally formed by the deaminization and oxidation of guanin and adenin.

It is now generally conceded that certain purin bodies are constantly being produced wherever cellular processes are in active operation, and although normally these are largely converted into other materials which are more easily excreted, practically all nitrogenous animal foods contain some of them. Lean meat, the flesh of mammals, birds and fish, contains xanthin, hypoxanthin and uric acid, besides urea, creatin, creatinin and other extractives. Liver is rich in nuclein, xanthin, hypoxanthin, uric acid, urea and other nitrogenous extractives. Spleen (milt) also is rich in nuclein, xanthin, hypoxanthin, uric acid, as well as lecithin, creatinin,

leucin and tyrosin. Thymus (chest sweetbread) contains nuclein, xanthin, hypoxanthin, guanin and adenin in large amounts. Pancreas (belly sweetbread) contains the same kinds of purins, besides leucin, tyrosin and other amino-acids. Kidneys contain uric acid, xanthin, hypoxanthin, as also urea, tuarin, leucin, creatin, creatinin, etc. Beef-tea, soup and gravy contain the same kinds of purins and extractives as the substances from which they are derived. Vegetable foods, especially seeds, contain nucleoproteins, nuclein, nucleic acid, and purin bodies, with amino-acids, such as asparagin, leucin, tyrosin, etc. Tea, coffee and kola contain caffein or trimethyl-xanthin—that is, xanthin with three methyl groups in its molecule; cocoa contains theobromin or dimethyl-xanthin; and guarana contains both caffein and theobromin.

As already stated, according to Burian, all of the exogenous purins are not excreted; a small fraction remains in the organism or becomes entirely disintegrated by the oxidases of the various organs. Therefore, on ordinary diets, while the excretion of purin is necessarily increased by the exogenous or food purin, not all that is ingested is eliminated as such. The amount of exogenous purin excreted in the urine is scarcely influenced by the individuality of the subject, usually the purin excretion in normal individuals being practically the same; but it must be borne in mind that its excretion is largely influenced by certain foods. For instance, in beef and veal, the purin content is 0.16; calf's liver, 0.12; calf's spleen, 0.16; calf's thymus, 0.4, and in coffee, 0.2 per cent. When these organs are largely partaken of or eaten alone, they lead to excretion of exogenous purin in the following proportions: beef and veal, 0.03; liver, 0.06; spleen, 0.8; thymus, 0.1; coffee, 0.075. Burian and Schurr as a result of their researches conclude that with the identical kind and same proportion of food the exogenous purin in the urine is virtually the same in all persons. According to Walker Hall, there is no personal equation in this metabolic process. It is known, however, that all purins in the food are not absorbed. There is a normal daily excretion of purin bodies in the feces referred to as *fecal purin,* to distinguish it from that excreted by the kidneys called *urinary purin.* Of course, the amount of fecal purin varies with the kind of food, and is greater where substances are eaten which are rich in nuclein and purin derivatives. Ordinarily, 60 per cent of the purin bodies are absorbed and 40 per cent excreted with the feces.

PURIN BODIES IN FOOD.—The chief fluctuation in the amount of uric acid in the urine can be explained by variations in the amount of uric acid yielders (purins) contained in the food. The endogenous fraction,

on the other hand, seems to be thoroughly fixed, but as to its exact seat and mode of formation and the precise conditions which control it, we still have much to learn. It is obvious that we have at hand an important means of regulating the amount of uric acid liberated in the body, namely by controlling the amount of purins in the dietary. As stated, the foods which yield much uric acid are the cellular organs of animals. We have, then, a clear dietetic indication if we wish to lessen the liberation of uric acid in the body. The diet recommended is one composed largely of vegetables with the exception of oatmeal, beans, peas, onions and asparagus.

Below we append a table from Tibbles(4) of the various foodstuffs, showing the percentage of purins contained, which are to be tabooed if we wish to lessen the manufacture of uric acid in a patient.

THE QUANTITY OF PURINS IN FOOD

VARIETIES OF FOOD	Purins, grains per pound	Percentage of purins
Codfish	4.07	.058
Plaice	5.56	.079
Halibut	7.14	.102
Salmon	8.15	.116
Tripe	4.00	.057
Mutton	6.75	.096
Veal: Loin	8.14	.116
Pork: Loin	8.49	.121
Neck	3.97	.056
Ham (fat)	8.08	.115
Beef: Ribs	7.96	.113
Sirloin	9.13	.130
Steak	14.45	.206
Liver	19.26	.275
Sweetbread	70.43	1.006
Chicken	9.06	.129
Turkey	8.82	.126
Rabbit	6.31	.097
Oatmeal	3.45	.053
Peameal	2.54	.039
Haricot beans	4.16	.063
Potatoes	.14	.002
Onions	.26	.009
Asparagus	1.50	.021
Lager beer	1.09	.012
Pale ale	1.27	.014
Porter	1.35	.015

EFFECT OF PURIN FOODS ON URIC ACID.—The effect of purin foods on the uric acid content of the blood has recently been studied at length by W. Denis(5), who concludes that "in normal individuals no

increase in the circulating uric acid is produced by the ingestion of even large quantities of purins. The ingestion of purins, either free as they occur in meats, or in the form of nucleoproteins of glandular tissues like liver, sweetbread, etc.," is followed by a decided increase in the urinary output of uric acid. Denis concludes that the normal kidney reacts to an excess of uric acid in a way essentially similar to that which it conducts itself to an excess of urea, and is able to excrete the excess of uric acid presented to it when a diet high in purins is fed, thereby keeping the circulating uric acid at the same level as that obtained when only endogenous uric acid is to be excreted. When the kidney has been damaged, even before certain damage has reached the point where nitrogen retention is apparent, as shown by the non-protein nitrogen values, an accumulation of uric acid takes place in the blood after a short period of purin feeding. This phenomenon is interesting, not alone from the evidence that it brings of the importance of the renal efficiency for the level at which uric acid circulates in the blood, but also for its value to diagnostic procedures. Denis suggests that when the determination of uric acid in the blood is undertaken for diagnostic purposes, the insistence for a short period of purin-free foods is unnecessary, except in cases in which kidney insufficiency exists, or perhaps in the case of persons who habitually consume extremely large quantities of foods of a high purin content.

There are two views as to the *origin of uric acid:* (*a*) that it is formed in the kidneys; (*b*) that it is formed in the tissues. The view that uric acid is formed in the kidneys as well as excreted by them was taught by Garrod as early as 1848, who was able to show that the blood of gouty persons contained abnormal quantities of uric acid, which observation has since been confirmed by many observers.

EXCESS OF PURIN DIET.—The continuous consumption of food containing purin bodies in large percentage ultimately leads to their accumulation and retention in the organism, when renal insufficiency supervenes. The normal liver can transform and the kidneys can excrete purin bodies so long as these organs are executing their normal functions, and no accumulation will result, but there is always danger that the constant irritation of the kidneys by the excess of purin, more especially uric acid, may result in chronic nephritis of the gouty type. Renal insufficiency, with the retention of purins in the system, it is thought, may be the cause of gout, but its etiological relation to so-called rheumatic gout, uric acid gravel, uric acidemia, migraine, neuralgia, sciatica, epilepsy, vascular diseases and many other conditions of ill health in which it has been put forth as a causative factor, is very doubtful.

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THE QUANTITY OF PURINS IN FOOI

VARIETIES OF FOOD	Purins, grains per pound
Codfish	4.07
Plaice	5.56
Halibut	7.14
Salmon	8.15
Tripe	4.00
Mutton	6.75
Veal: Loin	8.14
Pork: Loin	8.49
Neck	3.97
Ham (fat)	8.08
Beef: Ribs	7.96
Sirloin	9.13
Steak	14.45
Liver	19.2
Sweetbread	70.[illegible]
Chicken	9.[illegible]
Turkey	8.[illegible]
Rabbit	6.[illegible]
Oatmeal	3.[illegible]
[illegible]	2.[illegible]
Haricot beans	4.[illegible]
Potatoes	
Onions	
Asparagus	
Lager beer	
Porter	
[illegible]	

[illegible]

' r purin-free meals:

nket, 2 ounces

, light pudding,

toast, fruit tart

ng ½ pint of milk,

"cutlet" made of two
uits.

d fruit and cream with

a temporary measure.
iet, and the physician
below 60 or 70 grams
nger than two or three
allowed. Part of the
ing the boiling of these
first meat allowed should
"bound-purins." Equally
Schurr, and Tibbles, do not
n that, on analysis, it shows
servers find that from 60 to
at the most, only 40 per cent
ordinary diet is resumed, to
d leg or loin of mutton, boiled
l contains less extractives than
servatively allow pigeon, breast
f beef, sirloin of beef and steak,
ng articles of food should be per-
the neck, goose, duck, high game
n asked: "Is a purin-free or a low-
f gout?" Most certainly it is. If

PURIN-FREE DIET.—*Purin-free diet* is indicated in gout and wherever it is desirable to reduce renal irritation. The foods enumerated in the table on page 334 should be interdicted and the following foods, which contain practically no purin, advised: milk, cheese, cream, butter, eggs, white bread, macaroni, rice, sago, tapioca, cabbage, cauliflower, lettuce, water-cress, fruit, sugar, honey, marmalade, jam, jelly, sherry, port, volnay and claret. Four articles of diet—milk, butter, eggs and cheese—form together our most valuable means of withholding purin substances from the body and yet allowing the intake of a diet at once digestible, easily absorbed and capable of maintaining nitrogenous equilibrium. It is a milk and fruit diet with bread and butter, milk puddings and salads added to it. Milk and milk products contain only traces of purin. Potatoes and onions contain very little, and are allowed. Oatmeal, peameal and malted lentils contain from 2½ to 3½ grains of purins per pound, and should not be allowed. Asparagus contains very little purin, but much asparagin, which is a valuable protein-sparer. The following articles should be altogether forbidden: tea, coffee, cocoa, kola, guarana, fish, fowl and butcher's meat, brown bread, peas, beans, asparagus, ale, stout and lager beer. Cider, perry and a small quantity of spirits, claret, sherry or volnay, may also be allowed. Wines do not appear to contain any purin bodies and their harmful properties in gout must be due to some other constituent.

The purin bodies in coffee, tea and chocolate are largely methyl-purin, and do not undergo the same metabolic changes as other purins, so they need not be excluded from the diet of the gouty or rheumatic as rigorously as other purins.

Dr. Alexander Haig is authority for the following purin-free diet, which yields about 90 grams of protein, enough to meet the daily requirement:

PURIN-FREE DIET TO SUPPLY PROTEIN

12 ounces of white bread contain	372 grains	25 grams
4 " " oatmeal " "	208 "	14 "
2 " " rice "	86 "	5.6 "
3 pints of milk "	572 "	38.1 "
16 ounces of vegetables and fruit contain	140 "	9.3 "

LOW-PURIN DIET.—A low-purin diet consists of the same articles of food mentioned in the purin-free diet, with the following additions: tripe, codfish, potatoes, onions and particularly all fruits and green vegetables. Puddings may be made of milk, sugar, eggs, rice, sago, tapioca and macaroni or flour, and custard, junkets, jellies and suet may be used.

One of Haig's disciples suggests the following for purin-free meals:

FIRST DAY

Lunch:
Green vegetables, baked potatoes, butter, stewed figs, ½ pint of junket, 2 ounces of pine nut kernels (grated), with whipped cream.

Dinner:
Biscuits and butter, 1 ounce of grated cheese or some milk curds, light pudding, stewed fruit and cream.

SECOND DAY

Lunch:
Green vegetables, potatoes with butter, cheese sauce and dry toast, fruit tart with cream, ½ pint of milk.

Dinner:
Two boiled eggs, biscuits and butter, milk pudding containing ½ pint of milk, stewed fruit and cream with biscuits.

THIRD DAY

Lunch:
Potatoes and butter, green vegetables or salad, pudding or "cutlet" made of two ounces of ground nuts, stewed fruit and cream with biscuits.

Dinner:
Biscuits and butter, with cheese soufflé or omelette, stewed fruit and cream with biscuits, roasted chestnuts.

It must be realized that a purin-free diet is only a temporary measure. A purin-free diet is at best only a low protein diet, and the physician must see that the proteins consumed do not fall below 60 or 70 grams per day. This diet should not be continued longer than two or three months before fish, tripe, pork and ham are allowed. Part of the meat bases and purins will be washed out during the boiling of these foods. It is claimed by some dietitians that the first meat allowed should be sweetbread, because the purins in it are "bound-purins." Equally competent observers, Walker Hall, Burian and Schurr, and Tibbles, do not favor the allowance of sweetbread for the reason that, on analysis, it shows a very high percentage of purins. These observers find that from 60 to 70 per cent of those purins are absorbed and, at the most, only 40 per cent escape absorption. It is advisable, when an ordinary diet is resumed, to make additions gradually. First allow boiled leg or loin of mutton, boiled rabbit or boiled fowl, as the breast of fowl contains less extractives than the other portions. The physician can conservatively allow pigeon, breast of turkey or other fowl, well roasted rib of beef, sirloin of beef and steak, the latter being added last. The following articles of food should be permanently excluded: veal, pork, except the neck, goose, duck, high game and greasy foods. The question has been asked: "Is a purin-free or a low-purin dietary useful in the treatment of gout?" Most certainly it is. If

gout be due to the defective metabolism of nuclein or accumulation of purin bodies from renal insufficiency, these substances should certainly be excluded from the diet until the organism recovers its powers of eliminating them. The diet doubtless has its limitations. It is not a panacea, and in gout its use is limited by the nature of the disease.

Fat-free Diet.—A fat-free diet is of value in hypochlorhydria, catarrh, atony and dilatation of the stomach and in carcinoma of the stomach. For some time it has been known that the presence of an excess of fat, particularly of butter, in the contents of the stomach, will check the secretion of gastric juice, and advantage has been taken of this fact in the treatment of hypochlorhydria. On this account, the absence of fat from food allows a more generous secretion of gastric juice, including hydrochloric acid. In various disorders of the stomach, a condition of hypochlorhydria exists, where the normal proportion of hydrochloric acid is absent, in consequence of which the mucous membrane of the stomach may become infected by microörganisms, which give rise to catarrh, organic acidity, atony of the muscular coat, and dilatation. In carcinomatous conditions of the stomach, near the pylorus, there is likewise a diminution of free hydrochloric acid, and some authorities consider the cachexia produced by this disease a consequence of the subnutrition resulting from hypochlorhydria. It is argued that the elimination of fat from the dietary encourages a freer secretion of gastric juice with a larger proportion of free hydrochloric acid, and the normal (nascent) hydrochloric acid comes into direct contact with the crypts of the mucous membrane, which it slowly but effectively disinfects, and at the same time gives tone to the muscular coat. A fat-free diet is of value in such conditions. On the opposite page we give a table of fat-free foods, foods containing 0.5 per cent, foods containing less than 1 per cent of fats, and foods with 1 to 2 per cent of fat.

It is practically impossible to provide an absolutely fat-free diet. However, we can get near enough to a fat-free diet by removing as much fat as possible from the meat and milk and avoiding the use of butter, suet and other fats and oils. The table will serve as a guide to the physician or dietitian in directing a practically fat-free diet which would consist largely of bread, marmalade, white of eggs, meat extracts, soups, broths, oysters, light fish, lean meat and the breast of fowl, potatoes, vegetables and fruits.

Carbohydrate-free Diet.—A carbohydrate-free diet is one practically consisting of meat, green vegetables and hot water. A diet free from starch, sugar and other carbohydrates is recommended in the treatment

PERCENTAGES OF FAT IN FOODS

Fat-free Foods	Foods containing 0.5 per cent or less	Foods containing less than 1 per cent of fat	Foods with 1 to 2 per cent of fat
Sugar	Skim milk	Fine white flour	Sole, plaice
Honey	Casein powders	White bread	Smelt
Treacle	Sugar, pears	Ryemeal	Sturgeon
Starch	Corn-starch	Rye bread	Weakfish
Dextrin	Arrowroot, sago	Beef tea	Skate
Beef tea	Apples, tapioca	Meat extracts	Bluefish
Meat extracts	Green peas	Beef broth	Blackfish
Casein preparations	String beans	Meat stews when	Kingfish
	Potatoes, Litchi nuts	skimmed	Venison
	Parsnips, muskmelons	Tomato soup	Partridge
	Carrots, turnips	Oxtail soup	Breast of boiled fowl
	Radishes, watermelons	Mulligatawny soup	Wheat
	Beetroot, salsify	Pea soup, Gumbo soup	Brown bread
	Scorzonera	Turtle, frog's legs	Wholemeal bread
	Cabbage, plums	Oysters, clams	Buckwheat flour
	Cauliflower	Scallops	Macaroni
	Brussels sprouts	Crab, Crayfish	Vermicelli
	Spinach, currants	Shrimps	Haricot
	Vegetable marrow	Fish:	Navy beans
	Squash, lettuce	Bass, cod	Dried peas
	Asparagus, oranges	Cusk, flounder	Frijoles
	Tomatoes, peaches	Haddock, hake	Green corn
	Mushrooms, truffles	Yellow perch	Grapes
	Onions, melons	Perch-pike	Bananas
	Leeks, cucumbers	Gray pike	
	Celery, rhubarb	Pickerel-pike	
	Strawberries	Pollock	
	Raspberries	Red grouper	
	Gooseberries	Red snapper	
	White of eggs		

of certain gastric ailments, rheumatism, gout, diabetes and uric acidemia. Dr. Salisbury first recommended this form of diet, and according to his directions it consists of from two to four pounds of beef freed from fat, gristle, connective tissue and bone. It is chopped very fine, made into patties about three inches in diameter and one inch thick, and fried in a pan without fat or water. These are heated rapidly on one side and then on the other to coagulate the albumin, after which the process of cooking is allowed to proceed very slowly, and they are served while slightly underdone. (*See* Volume II, Chapter XII.)

Cellulose Diet.—The cellulose diet furnishes nutritive subsistence for the lower animals, the herbivora being able to digest from 60 to 70 per cent of the crude fiber of dried grasses (hay) and cereals; 47 to 62 per cent of that in carrots, cabbage and celery, and 25 per cent of that in

lettuce. It is within the bounds of probability that primitive man possessed this faculty in common with herbivorous animals. It is stated by competent authority that at the present day some of the existing primitive races, the Bushman, Nilotic negro, and others, possess a very large cecum, and that their colon secretes an enzyme which dissolves the outer covering of vegetable cells, and the fluid from the vermiform appendix digests cellulose. The civilized races of mankind have lost the power of digesting cellulose material. Bunge is authority for the assertion that "the epithelium of the colon secretes an enzyme which has a slight action on the cellulose coverings of cells"; notwithstanding, he practically agrees with the majority of clinicians that putrefaction is practically the only change which cellulose, or crude fiber, undergoes in the intestines of man, and that its principal and only use in the human economy is a mechanical stimulus to peristalsis. Cellulose undoubtedly possesses irritating qualities which it is necessary to minimize in cases of chronic gastric and intestinal catarrh, ulcer of the stomach, cancer or stricture of the pylorus. Physiologists tell us that the presence of cellulose acts as a stimulant, and as a result the food is hurried along in the alimentary canal more rapidly than when this substance is absent. This irritating effect is desirable in cases of atony of the intestinal canal, and advantage should be taken of it in prescribing, while the conclusion to be drawn from the observations of Bunge and others is that the advantages arising from the presence of cellulose in the food of the average individual will far outweigh its disadvantages.

Von Noorden prescribes a whole-meal Graham bread, all sorts of legumes, including the skins, coarse oatmeal and vegetables containing a high percentages of cellulose, fruits having thick skins and large quantities of butter, bacon and ham. In cases of chronic constipation, and especially those complicated with mucous colitis, he claims that this diet permanently cures 50 per cent of all cases and that 28 per cent are probably improved or partially cured.

The following foods contain *considerable cellulose* and are recommended as adjuvants to the diet for the relief of chronic constipation: wholemeal bread of any description, eaten with plenty of butter, fat ham, bacon, treacle or marmalade; fat meat, bacon or ham for dinner, with a large proportion of dried peas, cabbage, savoy, lentils, Brussels sprouts, cauliflower, one or two eggs daily, poached, buttered or scrambled in preference; turnips, parsnips, onions, okra, swedes, scorzonera and leeks. Dessert should consist of raw or cooked fruit, pears, strawberries, currants, apples, grapes, raspberries, gooseberries, loganberries, blackberries,

whortleberries and cranberries. Plenty of cream should be taken with cooked fruit. Sugar is allowed. Apples, apricots, plums, peaches and acid fruits in general also stimulate peristalsis by means of their organic acids. Oatmeal is of great value. The coarse meal is the best form, but oat-cakes and groats may also be eaten. Barley bread, pearly barley, buckwheat cakes and rye bread are useful.

MINERAL METABOLISM

The salt metabolism of disease is a most important subject. Few studies of the balances of the various salts in disease have as yet been made at the hands of biochemists, but the therapy of the future will undoubtedly include the practical application of salt metabolism to the principles of nutrition. Wellman, who has given some thought to this subject, finds that there was a greater loss of salts in fasting than was accounted for by the metabolism of the fleshy portion of the body. The principal loss was phosphorus pentoxid and calcium and magnesium oxids, in about the same proportion as contained in bone; and the skeletons of animals were found to have actually lost from 6 to 7 per cent of their weight. In many diseased conditions, there was present a lowered *calcium excretion;* for instance, in pleurisy with effusion, pneumonia, delirium tremens, and in typhoid and malarial fevers. Senator, in writing on this subject, said that there was in pulmonary tuberculosis an excess of calcium excretion. In osteomalacia the calcium balance is also disturbed, more being excreted than is taken into the body. The calcium excretion is lessened by phosphoric acid, which fact might be of use in experimental therapeutics. It is said that castration restores the CaO equilibrium, which also influences the restoration of sulphur equilibrium. In myostitis ossificans, on the other hand, the calcium output is less than normal. In arthritis deformans there is a retention of lime salts. Also in endarteritis the excretion of calcium is hindered and one observer even claims to have obtained good results by the administration of salts, *viz.,* lactic acid, sodium lactate, sodium citrate, sodium carbonate and sodium chlorid, which, according to his contention, aid in the excretion of calcium. It is probably unsafe to assume that a diet containing sufficient protein and energy necessarily furnishes sufficient calcium and other salts for the metabolism of the body. This point can only be settled by metabolism experiments in which a balance is made between the intake and the output. The most recent investigation and thorough research into this subject has been made by Sherman, Mettler and Sinclair(6). Space forbids an

extended review of their interesting experiment, but the table below[1] shows the average amount of calcium, magnesium, phosphorus and iron consumed daily in the various dietaries.

THE MINERALS IN TYPICAL DIETARIES: DAILY QUANTITIES PER MAN

SUBJECTS OF THE STUDY	Fuel Value (Calories)	Protein (Gms.)	Iron (Fe) (Gms.)	Phosphoric acid (Gms.)	Calcium oxid (Gms.)	Magnesium oxid (Gms.)
Maine lumbermen	6,780	179	.035	5.88	1.27	1.21
School superintendent's family, Chicago	3,260	123	.021	3.97	1.09	.55
Students' Club, University of Tennessee	3,595	123	.019	4.05	1.22	.63
Decorator's family, Pittsburgh	3,305	112	.019	3.44	.90	.48
Farmer's family, Connecticut	3,545	108	.021	3.53	1.15	.55
Teacher's family, Indiana	2,780	106	.016	3.64	1.42	.44
Teacher's family, New York City	3,180	102	.017	3.92	1.69	.54
Mechanic's family, Tennessee	4,060	97	.017	3.58	.90	.72
Farmer's and mechanic's families, Tennessee	2,820	95	.019	3.56	.83	.59
Glass-blower's family, Pittsburgh	3,085	94	.016	2.73	.49	.36
Lawyer's family, Pittsburgh	3,280	91	.015	2.82	.83	.40
Women Students' Club, Ohio	3,330	85	.015	2.88	.97	.67
Lawyer's family, New York City	2,325	84	.014	2.41	.47	.30
Laborer's family, Pittsburgh	2,525	83	.013	2.40	.50	.34
Negro family, Alabama	4,955	80	.012	3.25	.21	.74
Laborer's family, Pittsburgh	2,440	77	.012	1.52	.40	.19
Laborer's family, New York City	2,430	71	.012	2.27	.50	.29
Farm Students' Club, Tennessee	3,560	66	.011	2.08	.46	.34
Sewing-woman's family, New York City	1,500	54	.009	1.84	.68	.23
Very poor negro family, Alabama	2,240	44	.007	2.05	.08	.52

Tachau(7), who has done much experimental work in salt metabolism, holds that the catabolism of easily burned carbohydrates often furnishes too much heat. Then, unless the "windows are opened, the house may get too warm," or they may, in too large quantities, be incompletely burned and thereby produce substances which will seriously interfere with the protoplasm (cellular) chemical processes (cellular asphyxia). The split products of both fats and carbohydrates may indeed menace the body, and the lack or overabundance of the mineral salts may surely tend to change the reactions of the living cells.

If the results of experiments are correctly interpreted, we find that

[1] From Bull. 227, Exp. Sta., U. S. Dept. Agric.

the "living organism may be regarded as a highly unstable chemical system which tends to increase itself continuously under the average of the conditions to which it is subject; it undergoes disintegration as a result of any variation from this average"(8). With the lights before us, there is no reason to charge any harmful results to starch itself. "It is only when ingested in excessive amounts for long periods of time that harm results, and this is due not so much to the starch as to the attendant deprivation of other foodstuffs, protein, hydrocarbons and organic mineral matter"(9). If an animal is allowed a liberal, well-balanced dietary, consisting of protein, fats, carbohydrates and water with no organic mineral salts, it will die more quickly than if it received no food at all(10). For this reason, the importance of salts has been extensively dwelt upon (*see* Volume I, Chapter IX, Volume II, Chapter VIII) by various workers, but no one has shown in simpler way, or a more convincing form, the reasons for the value of salts in the economy than Fischer(11). "The great importance of the organic mineral salts in the human organism is due to their effects upon the physical condition of the proteins of the body. It is true they furnish practically no energy and yet are essential." Schaefer(12) has said that "the chemistry and physics of the living organism are essentially the chemistry and physics of the nitrogenous colloids," and Guyer(13) voiced the opinion that what we call protoplasm is really an aggregate of colloids, holding water for the most part, in which are contained certain salts and non-electrolytes.

Electrolytic Properties of Salts.—Water forms a large percentage of the substance of the cell, and is essential for its existence as providing the medium wherein those chemical processes which constitute metabolism take place. This medium is a dilute solution of sodium chlorid in which the molecule of the salt has become dissociated into its free constituents or ions—sodium and chlorin. These, charged respectively with negative and positive electricity, are what are termed cath-ions and an-ions.

These ions act as independent particles and by means of their powers of electric attraction and repulsion are the forces which directly cause bodily chemical changes. The presence of salts in the cells and their condition of dissociation or ionization are matters of great practical interest, because, in the first place, as regards the very ordinary salts, the phenomena of endosmosis and exosmosis are largely due to their presence in the cell, and also because the protein molecules only manifest their activity in a dilute saline solution under the conditions of ionization therein.

These salts, it seems, are of inestimable value, because they change the affinity of the protoplasm for water, so that at one time when there is

relative lack of salts the protoplasm loses water and at another time it absorbs water and with it food materials. Without doubt, the salts of the foods are the agents which control to a large extent the secretion and absorption, but it must not be forgotten that the formation of salts enters into the regulation of neutrality in the body; but that is only a part of the problem of secretion and absorption, which was fully considered in Volume I, Chapters VI and VII.

Sodium Chlorid.—The importance of *sodium chlorid* in the diet was considered in Volume I, Chapter XI, where we learned that it "protects protein substances from disassimilation," *i.e.*, it produces assimilation, and its use from this viewpoint is economical. The sodium chlorid content of the body is of great importance and what might be termed sodium chlorid equilibrium is maintained. In normal individuals, if sodium chlorid is partaken of too liberally, there is an increase in the elimination, and if the amount is partaken of sparingly there is a diminution in the output; but a certain amount, about 2 grams per day, must be partaken of to make up for the daily loss. Bunge considers the presence of sodium chlorid essential to prevent the toxic effects of potassium. There is no question but that it plays an important part in the nutritive exchange between the cells and the plasma and stimulates the excretion of waste products by the kidneys. Exclusion of common salt from the food leads to dehydration of the tissues, and this is the basis of the salt-free dietary. Salt is found in varying quantities in all foodstuffs, and the daily requirement is from 15 to 20 grams. The presence of an abnormal amount of sodium chlorid in the blood and tissues is one of the causes of edema.

The amount of salt consumption per capita per diem for the American people is more or less an unsettled question, since medical literature contains no statistics on the question. According to Archard the average consumption of salt by the French people is 300 grains per day.

According to United States Army regulations, the allowance for the soldier is about 300 grains daily, which is practically a large heaping tablespoonful. We may, therefore, take the soldier's allowance as a criterion for the amount used by the American people. Physiologists tell us that 95 per cent of the salt ingested is eliminated unchanged within 24 hours. Then, of the 300 grains consumed daily by the average American, 285 grains are excreted and cast out of the body as foreign material as rapidly as the organs of excretion can accomplish the task. Can this large excretion of salt be carried on daily for years with impunity? The history of salt-using nations leads us to ask the question: If something is transpiring that may make them the unhealthiest animals in existence, since daily

repeated exhaustion of glandular organs by exosmosis tends to, logically, and practically does produce the very condition of glandular torpidity that afflicts mankind?

The retention of sodium chlorid in the tissues is due to one of the following causes: (*a*) the kidneys may be unable to excrete it, or (*b*) it forms chemical combination with the cells. According to some authorities, this combination occurs in the preliminary stages of edema when the cells become saturated with water and the chlorid begins to accumulate in the surrounding fluids. Whether this explanation is satisfactory or not, this much is known. Marie argues that, when water is retained in the tissues, it requires the presence of sodium chlorid to balance the osmotic pressure of the salt in the blood (*see* Volume I, Chapter VII, Osmosis and Diffusion). The greater the amount of water retained in the tissues the more sodium chlorid will be accumulated therein, and the less will be excreted by the kidneys. In Bright's disease, for instance, where the kidneys are unable to excrete salt even when diuresis has been established, it has become the custom of clinicians to reduce the intake of common salt with a view of relieving the kidneys of the extra work of excreting it. The indication, then, for a salt-free diet is where there is failure of compensation characterized by diminution in the excretion of water. The diseased conditions in which it has been found beneficial and practical to withhold sodium chlorid are dropsy from cardiac, renal or hepatic diseases, obesity, diabetes insipidus and epilepsy. A salt-free diet is also useful in chronic parenchymatous nephritis with edema or dropsy, and granular kidney when there is a failure of compensation.

SALT-FREE DIET.—In selecting foods for salt-free diet, it is unnecessary that it should be absolutely salt-free, besides it is almost impossible to prepare food quite free from it. The table on page 346 shows the percentage of sodium chlorid in raw and cooked foods, taken largely from an article by H. Strauss(14) on the best method of reducing the amount of salt in the diet:

In selecting articles of food for a *rigid salt-free diet,* an attempt should be made to keep the amount of sodium chlorid down to between 1½ to 2 grams per day, which will mean the exclusion or reduction of the allowance of meat, fish and meat broths. According to Tibbles(4):

The proteins should be derived from milk, eggs, chicken cooked without salt, tripe, fresh-water fish, cheese made without salt, and bread made without salt. Milk can be taken alone or with eggs, in the form of custard, in puddings with rice, sago, oatmeal, etc. Eggs can be taken in many ways without the addition of salt—*e.g.,* custards, milk puddings, poached eggs, boiled eggs, omelettes; the latter

can be seasoned with sugar instead of salt. Eggs can also be taken in "cream," souffles and sauces. Jellies made of gelatin or isinglass and meat jelly are permissible. The fats should be derived from milk, eggs, unsalted butter, fat meat eaten without salt, cheese made without salt, cream cheese and salad-oil. Carbohydrates may be obtained from sugar, treacle, golden sirup, jam, marmalade, bread made without salt, milk puddings without butter, blanc mange, jelly, milk sauces, fruit and vegetables. Bread and pastry made without salt are not unpleasant when eaten with stewed fruit, jam, marmalade and unsalted butter. Vegetables should be allowed *ad libitum,* because they can be made the vehicle of flour and fat in the form of "white sauce." It is recommended that all vegetables should be cooked in plenty of water, with a minimum of salt, thereby reducing the proportion of inorganic constituents. No salt must be used when cooking or eating the food, except the small amount absolutely necessary to give flavor to potatoes, cabbages and other green vegetables, and the salt must be put into the process of diffusion. The absence of flavor may be obviated to a great extent by a careful employment of spices, condiments such as mint, thyme, parsley, marjoram, savory, bay-leaf, chutney, horseradish sauce, tomato sauce, mustard, nutmeg, cinnamon, allspice, vanilla, lemon, cocoa, chocolate and coffee, and in some cases a small amount of pickles, such as red cabbage, onion or cauliflower. The liquids allowed are milk, whey, buttermilk, weak tea, cereal or fig coffee, lemonade, fruit juice and aërated waters, or a small amount of wine or spirit and water.

THE PERCENTAGE OF SODIUM CHLORID IN FOODS

Raw food	Per cent	Cooked foods	Per cent.
Unsalted butter	.02	Poached eggs	.5
Yolk of eggs	.02	Fruit, usually less than	.5
Fruit, not more than	.06	White bread	.48–.07
Meat, unsalted	.10	Brown bread	.75
Vegetables and salads	.10	Cauliflower	.5–.9
Cereals and legumes	.01–.10	Cabbage	.5–.9
Milk	.15–.18	Mashed potato	.5–1.0
Eggs	.14	Roast beef	1.9–2.8
White of eggs	.19	Beef steak	3.0
Salted butter	1.00	Buttered eggs	2.4
Cheese	1.5–2.5	Omelettes	2.7
Caviar	6–7	Asparagus	2.7–3.5

Moderate variations in the amount of salt ingested have no significant effect upon the protein metabolism. Large amounts increase the quantity of protein catabolized, and, through overstimulating the digestive tract, may also interfere with the absorption and utilization of the food.

Below we append a few examples of diets containing not more than two grams of salt (Tibbles):

(a) Balint prescribed: Milk, 1½ to 2½ pints; butter, 1½ ounces; three eggs; saltless bread, 9½ to 12½ ounces, and weak tea or coffee. Calories, 2,300 to 2,400.

(b) Archard and Widal drew up the following series of diets:

(1) Potatoes, 35 ounces; meat, 10½ ounces; butter, 1¾ ounces; rice, 4½ ounces; protein, 98 grams. Calories, 2,295.

(2) Saltless bread, 7 ounces; meat, 14 ounces; butter, 3 ounces; sugar, 3½ ounces; protein, 117 grams. Calories, 3,037.

(3) Saltless bread, 7 ounces; potatoes, 10½ ounces; rice, 3½ ounces; sugar, 3½ ounces; butter, 1 ounce; protein, 33 grams. Calories, 1,891.

(4) Milk, 2 pints; two eggs; meat, 10 ounces; flour, 2 ounces; sugar, 1¾ ounces; butter, 1¾ ounces; protein, 125 grams. Calories, 2,292.

From the above table it will be seen that the dietary can be varied so that the consumption of protein will vary but little from the standard advocated in these pages. The following dietary will possibly be acceptable by most Americans:

Breakfast:

Oatmeal porridge; saltless bread and butter; one or two eggs (poached or buttered); raw egg-and-milk; fresh-water fish, eaten with lemon juice or vinegar. Jam, marmalade, tomatoes, or other fresh fruit; tea or cereal; coffee made with water or milk.

Midday Meal:

Vegetable soup; saltless bread; cow-heel, tripe, unsalted tongue, fresh meat or fowl. Fish may be taken once or twice a week, with mayonnaise sauce, white sauce, or bread sauce. Milk puddings; cream; custard, junket; blanc mange; jelly, stewed fruit, salt-free biscuits, or crackers. Salt-free cheese. Green vegetables, kidney or snap beans, vegetable marrow, spinach, scorzonera, celery, cauliflower, and potatoes, all cooked without salt, or the minimum required to give flavor.

5 p.m.:

Tea; with salt-free bread and butter; cakes, honey, marmalade, and other confections.

Evening Meal:

Any article from list for the midday meal or breakfast.

Bunge(15) records extended and interesting observations and discussion upon the relation of diet to the craving for salt, and concludes that it is possible for one to live on a diet largely vegetarian, without the addition of salt, yet on such a diet one should have a strong disinclination to partake freely of vegetables rich in potassium, such as potatoes.

The use of salt enables us to employ a greater variety of the earth's products as food than we could do without it.

But according to Bunge:

We are accustomed to take far too much salt with our viands. Salt is not only an aliment; it is also a condiment and easily lends itself, as such things do, to abuse.

Sodium and chlorin equilibrium can apparently be maintained on less than one-fourth the amount of salt ordinarily consumed. Sodium chlorid partaken of with the diet passes out of the body through the kidneys without undergoing any chemical changes; the rate of excretion adapts itself to the rate of intake within wide variations.

According to Goodall and Joslin(16), when no salt is taken, the rate of excretion falls rapidly to a point where the daily loss is extremely slight. In one of their experiments upon a salt-free diet, the chlorin excretion upon successive days was as follows:

1st day...........	4.60 grams chlorin	7th day...........	0.46 grams chlorin
2nd day..........	2.52 " "	8th day...........	0.40 " "
3rd day..........	1.88 " "	9th day...........	0.26 " "
4th day..........	0.87 " "	10th day...........	0.22 " "
5th day..........	0.69 " "	11th day...........	0.22 " "
6th day..........	0.48 " "	12th day...........	0.17 " "
	13th day.............0.17 grams chlorin		

Potassium Chlorid.—*Potassium chlorid* is next in importance to sodium chlorid. It is a predominant salt in the muscular tissues, and, like sodium chlorid, is a common ingredient of nearly all the tissues and fluids of the body. The acid and neutral carbonates and phosphates of sodium and potassium exert their greatest importance in regulating the reaction of the digestive secretion and of the urine. Sodium is required in the body for the proper constitution of its fluids, potassium for the construction of cells and especially, perhaps, of the red blood cells and the muscles.

Clinical experimentation has emphasized the fact that young animals and children deprived of potassium salts in the foods do not develop good muscles. Foods derived from the vegetable kingdom furnish the richest supply of potassium-bearing salts, by three or four times, while foods from the animal kingdom contain a larger percentage of the sodium salts. If potassium chlorid is substituted for sodium chlorid in the food, various disturbances arise, owing to the deficiency of the sodium salt. The tissues of the body retain common salt most tenaciously, and when food is ingested which is low in this element, it gradually disappears from the urine. When the supply of common salt is below the body requirement, the elimination of chlorid in the urine decreases. When there is a lack of sodium chlorid as compared with potassium chlorid in the food, potassium combinations replace sodium combinations in the body and new combinations of sodium and potassium are formed and excreted in the urine. Human beings who consume a large amount of potatoes or other vegetables rich in potassium salts should of necessity partake freely of common salt, not merely as a condiment, but as an essential part of the food.

Low Calcium and High Calcium Diets.—We learned, when studying mineral salts in the body and in foods (Volume I, Chapter XI), that the calcium salts are of value chiefly from their importance in the composition of the bones and teeth, as well as in many of the tissues of the body, more particularly with cell growth and development. The bones and tissues of young growing animals, and children as well, require and contain a larger percentage of earthy salts than older ones.

Calcium is taken into the body in organic forms through the ingestion of milk, yolk of egg, and cereals, and in inorganic forms chiefly in drinking water, such as the carbonates, sulphates and phosphates. Both forms are more or less readily absorbable, depending in a measure upon what salts are taken with it. The minimum amount of lime by which calcium equilibrium may be maintained ranges from 1 to 1½ grams per day for the average sized adult. There seems to be great variation in the quantities by which a calcium diet may be established; 5 to 10 per cent of that ingested is excreted in the urine, while the remainder is found in the feces, whether unabsorbed or absorbed and then eliminated in the intestine. The amount of lime eliminated through the kidney varies greatly—probably does not average much over one-tenth of that taken in the food. The fact that the greater part of the calcium ingested in food reappears in the feces has often been interpreted as meaning that the requirement of the body for calcium is low, and the absorption of calcium from the food is poor. It must not be lost sight of, however, that the calcium found in the feces comes from the various organs and tissues of the body as well as from the food. The elimination of calcium from the food through the intestinal wall has been proved. The elimination of lime salts through the intestinal wall continues in fasting, and constitutes the principal way in which lime is lost from the body whenever the food supplies contain insufficient lime for equilibrium. The calcium excretion in the urine may be increased by the ingestion of large quantities of water, and by the administration of dilute hydrochloric acid; and again, it may be increased by the administration of lactic acid and sodium lactate. There is a loss of lime over that taken into the body in such diseased conditions as osteomalacia, pernicious anemia, advanced tuberculosis and in diabetes. This is to some extent associated with phosphate elimination. On the other hand, in arteriosclerosis, the excretion of lime is deficient. If, on a given diet, the calcium is low, the loss will greatly exceed the intake. If, on the other hand, the diet contains excessive amounts of calcium, some of the lime will be retained in the body and apparently stored up in the bones, though it may not produce symptoms.

Voit experimented on a pigeon for a period of twelve months, giving it a diet poor in calcium, without observing any deleterious effects attributable to the diet. But when the bird was killed and dissected, there was found marked wasting of lime salts from the bones of the skull and sternum, which were so soft as to be perforated with ease. However, the long bones, those concerned in locomotion, were still sound. The injurious effect of foods containing insufficient lime is more noticeable in growing than in full grown animals. Abnormal weakness, flexibility of the bones will be noticed (like rickets in children). Puppies fed with lean and fat meat only develop rickets, while control puppies from the same litter receiving the same food with an additional allowance of bones to gnaw upon develop normally.

From the above, it is apparent that the growing skeleton needs an abundance of calcium. Before birth the lime requirement of the child is satisfied through the maternal blood, and for many months afterward, through the mother's milk, which is relatively rich in calcium. The weakening of the bones and the disintegration of the teeth during pregnancy and lactation is largely due to the amount of calcium going to the child *in utero* and during lactation in the secretion of milk. After weaning and throughout early childhood, there are apt to be frequent disturbances of the absorption and metabolism of lime, due, in some instances, to disorders of digestion, in other cases, to deficiency of lime in the nutrients ingested by the child. To prevent this fluctuation, so as not to interfere with the steady growth of the child, it is imperative that the food furnish a liberal supply of calcium. Under the most favorable conditions, a rapidly growing child will need and consume more bone-making material in proportion to its total food than is required by men who serve as subjects for metabolism experiments. For this reason, among others, lime water is added to the various artificial foods given during infancy and early childhood. Unless a very "hard" water is used for drinking purposes, it is unlikely that the lime from this source will supply more than a very small part of the calcium required, so that there should be great attention given to the choice of such foods as will increase the calcium content of the dietary.

The table on page 351 gives the calcium content of a number of staple articles of food.

A study of the table on page 353 will show that there are enormous differences in the calcium percentage of different food products, milk being so rich in calcium that the quantity necessary to produce 400 calories contains 1 gram of lime. In order to get the same amount of lime from round steak

and white bread, it would be necessary to consume enough to furnish 10,000 calories.

A low calcium diet is recommended in many cases of arteriosclerosis, exerting, as is claimed, a beneficial effect by checking alimentary toxemia, reducing blood pressure and increasing diuresis. The idea is, that to keep blood pressure low, lime salts should be eliminated from the diet as far as possible. In conditions of cardiac failure, lime salts are allowed, but when compensation is reëstablished, their use should be discontinued. It should be pointed out, however, that it has not been proved that blood and tissues retain calcium during the course of arteriosclerosis. If at any time it is desirable to give a calcium-poor diet, it can be arranged from the following table:

CALCIUM IN FOODS[1]

	Per cent
Basal Foods:	
Meat	.002
Eggs	.100
Cream	.147
Milk	.172
Cheese	1.240
Bread	.021
Flour: Fine	.028
Entire wheat	.037
Cornmeal	.009
Rice	.012
Pearl barley	0.25
Macaroni, vermicelli	.028
Oatmeal	.078
Vegetables:	
Asparagus	.038
Beans: Dried	.215
Fresh, string	.073
Beetroot	.019
Cabbage	.058
Carrots	.077
Celery	.094
Cucumber	.028
Greens, turnip tops	.508
Lettuce	.425
Onions	.040
Parsnips	.076
Peas, dried	.137
Potatoes	0.16
Sweet	.025
Vegetables (*Continued*):	
Pumpkins	.032
Radishes	.025
Rhubarb	.060
Ruta baga (swedes)	.103
Spinach	.064
Tomato	.019
Turnips	0.87
Vegetable marrow	0.32
Watercress	.259
Fruits:	
Apples	.011
Apricots	.021
Bananas	.009
Blackberries	.099
Bilberries	.045
Cherries	.026
Cranberries	.021
Currants	.046
Dried	.169
Grapes	.014
Grape fruit	.029
Huckleberries	.037
Oranges	.043
Peaches	0.15
Pears	.018
Pineapple	.008
Plums	.022
Raspberries	.072
Strawberries	.057
Water-melons	.018

Magnesium Salts.—Magnesium is usually present in foods in much the same proportion as calcium. There are exceptions, however, to this rule,

[1] Bull. of Exper. Sta. No. 45, U. S. Dept. of Agric.

for in milk, magnesium is less and in meat considerably more abundant than calcium, while in bread there is actually five times as much magnesium as calcium. Magnesium, however, is of much less importance to the body than calcium. Very little magnesium is absorbed from the food, and one-third of the intake is excreted in the urine and about two-thirds in the feces.

The bones contain 99½ per cent of the entire calcium content of the organism, but only 71 per cent of the magnesium. On the other hand, the muscles contain more magnesium than calcium, but again there is in the blood more calcium than magnesium. The solubility of magnesium salts in the body fluids is greater than that of lime. Absorption of magnesium both in organic and inorganic combinations takes place from the intestinal canal. Experiments in which animals are given food with scanty lime content, but rich in magnesium, have demonstrated that while the bony structure resulting from such diet contains twice the normal amount of magnesium, the development of the osseous system is stunted. These data offer practical proof that lime cannot be replaced by magnesium. Since the magnesium salts are more soluble than the lime salts, they are eliminated in greater proportion than the latter by the kidneys. As a matter of fact, most of the absorbed magnesium is excreted in the urine, while the unabsorbed magnesium salts in the form of insoluble soaps are eliminated in the feces. The table on the opposite page shows comparative amounts of the lime and magnesium salts.

Phosphorus.—Phosphorus is essential for all cell life and its importance as a building material in the body can scarcely be overrated. Wherever growth is most active, there also most phosphorus is found. It is a component part of all cell nuclei and is found abundantly in the bones and in the central nervous system. Wherever the building up of such a tissue is going on rapidly, a large supply of phosphorus in the food is required. It is not surprising, therefore, to find that the development of young animals which are deprived of phosphorus is apt to be seriously impaired. The importance of a sufficient amount and a proper form of phosphorus in the food of growing children is to be emphasized; and it is essential for the growth of new tissues that phosphorus should be stored in the body as well as nitrogen. Whenever there is a storage of nitrogen a corresponding storage of phosphorus is also found. The importance of phosphorus as a building material was shown by Bunge when he discovered that the proportion of phosphorus, calcium and protein in the milk of animals is directly proportionate to their growth. The table given on page 354 very graphically emphasizes Bunge's discovery.

APPROXIMATE AMOUNTS OF MAGNESIUM AND CALCIUM OXID IN FOOD MATERIALS[1]

Vegetable Foods	Ash in per cent of substances	Magnesium in per cent of the ash	Calcium in per cent of the ash
Millet	5.1	25.8	....
Cocoa	4.9	15.9	2.8
Cornmeal	....	14.9	6.3
Rice	0.67	13.4	0.8
Nut kernels	....	13.0	8.6
Wheat flour	2.3	10.9	2.2
Buckwheat	....	10.3	6.6
Barley	2.5	9.6	3.5
Apples	0.27	8.7	4.0
Coffee extract	3.4	8.6	3.6
Peas	2.6	8.1	5.1
Rye flour	1.97	7.9	1.02
Oatmeal	2.3	7.0	3.0
Tea extract	3.1	6.8	1.2
Potatoes	5.0	2.5	0.8
Grapes	2.25	8.8	36.9
Cherries	0.4	5.5	7.5
Plums	0.31	4.7	4.9
Asparagus	6.4	6.3	15.9
Lemon juice	0.2	3.3	7.9
Bananas	....	8.8	12.5
Spinach	2.03	5.3	13.1
Savoy	....	2.9	27.9
Cauliflower	8.8	Trace	21.7
White cabbage	11.6	3.7	12.6
Kohlrabi	8.9	3.2	10.2
Radish	6.4	3.5	8.8
Cucumbers	4.8	3.0	6.9
Gooseberries	0.4	5.8	12.2
Lentils	2.1	1.9	5.1
Beans	3.1	6.5	8.6
Schoten	0.7	6.3	7.8
Clover	....	4.8	36.1
Poppy seeds	....	9.5	35.1
Sorrel	....	8.3	31.6
Pears	0.4	5.2	7.9
Strawberries	....	Trace	14.2
Carrots	5.4	2.3	5.6
Animal Foods			
Beef		15.2	2.9
Albumin of hens' eggs		13.0	13.0
Woman's milk	....	5.0	24.3
Yolk of egg	....	6.0	38.0
Cow's milk	....	20.0	151.0

[1] From von Liebig and other sources.

IMPORTANCE OF PHOSPHORUS AS A BUILDING MATERIAL (Bunge)

	Time required to double the weight of a new born animal (Days)	Milk of Mother Contains			
		Protein per cent	Ash per cent	Lime per 1,000	P_2O_5 per 1,000
Man	180	1.6	.2	.328	.473
Horse	60	2.0	.4	1.240	1.310
Cow	47	3.5	.7	1.600	1.970
Goat	17	4.3	.8	2.100	3.220
Sheep	10	6.5	.9	2.720	4.120
Dog	8	7.1	1.3	4.530	4.930

Rohmann(17), in studying this subject, asks the question: "What influence have the inorganic phosphates on the construction of phosphorized proteins in the body?" In an experiment to answer this question, says Tibbles, he fed animals on a diet containing earthy phosphates and diets consisting of (*a*) phosphorized proteins (casein and vitellin), (*b*) non-phosphorized protein (edestin). In animals which subsisted on the former diet, there was a retention of nitrogen and phosphorus in the body, while in animals fed on the latter no retention occurred. His conclusion from these observations is that the body does not appear to have the power of building up the phosphorized proteins of the cells from the non-phosphorized proteins and inorganic phosphates. On the other hand, he concluded that the phosphorized proteins are built up from lecithin and non-phosphorized protein. From his observations, we must look to the phosphorized organic constituents of the food for our supply of phosphorus, viz., nucleoproteins, phosphoproteins, nuclein, lecithin, phosphocarnic acid and glycerophosphoric acid found in the cellular elements, particularly in the yolk of eggs, sweetbread, fish roe, the germ of cereals and legumes, and in casein. (For the amount of phosphorus contained in foods, *see* Volume I, Chapter XI, pages 271-272.)

Bunge(18) has demonstrated the content of phosphorus pentoxid (P_2O_5) in 100 grams of dried food to be: egg yolk, 1.90; cow's milk, 1.86; beef, 1.83; peas, 0.99; wheat, 0.94; potato, 0.64; egg albumin, 0.20 grams. In his work along this line, Voit gives the following estimate of the amount of phosphorus in the various structures of a human body weighing 154 pounds: 1,400 grams in the bones; 130 grams in the muscles, and 120 grams in the nervous system. The determination of the exact phosphorus requirement of the human organism is not an easy problem. Available data on this subject are even fewer than those dealing with

nitrogen. Sherman and Sinclair(19) have pointed out that the daily amount of phosphorus received by the body varies from 0.9 to 1.5 grams, this variation depending upon the amount of phosphorus in the food ingested. Interesting and instructive as this work is, it is not exhaustive. But from these studies it may be inferred that a normal individual by training himself to exist on a low protein diet, or on a diet whose phosphorus content exists almost exclusively in organic combination, may maintain phosphorus equilibrium on food containing about 0.9 grams of phosphorus or 2 grams of phosphorus pentoxid. But to maintain a normal phosphorus equilibrium on an average unrestricted diet, it would seem that a daily intake of about 1.5 grams of phosphorus or 3.5 grams of phosphorus pentoxid is required.

Iron Salts.—Iron is one of the mineral constituents of the diet which is always present in an organic form. It is largely excreted in the feces, which fact has led to great difficulty in attempting to estimate the usual amount of iron required. Roughly speaking, there are about 10 milligrams of the metal contained in an ordinary mixed diet(15). This quantity may therefore be taken as sufficient to meet all physiological demands. It is difficult to estimate correctly the amount of iron contained in the different articles of food. In foods derived from the animal kingdom much depends on whether the animal was bled when slaughtered or not, while, with foods derived from the vegetable kingdom, it varies very greatly, depending largely upon the amount of iron in the soil in which the foods were grown. For the estimated amount of iron contained in different vegetable and animal foods, the reader is referred to Volume I, Chapter XI, page 269. Physiological chemists estimate that the blood(4) of an adult contains 3 grams of iron; the liver, spleen, skin and hair contain smaller amounts. According to Nasse, the conglomerate masses in the spleen pulp of old horses contain about 5 per cent of iron, while Oidlmann estimated that the ash of the spleen contains from 7 to 16 per cent of iron. The iron content of the blood in the form of hemoglobin amounts to about 0.04 per cent. The iron of the liver is stored in the cells as compounds of iron in nuclein and protein. Physiologists designate two of these compounds as *hepatin* and *ferratin,* and the iron is either the ferric or ferrous oxid. The iron in the liver of a new-born animal is greater than that in the adult of the same species. Bunge teaches that the liver acts as a storage house for iron, which is subsequently used to form the hemoglobin of the red blood corpuscles. Delepiene coincides with this view. He even considers the liver as not only the storehouse of the nucleoprotein compounds containing iron, but that

the liver cells are capable of elaborating these compounds into new hemoglobin for the young red blood corpuscles, which he describes as the ferrogenic function of the liver and which he believes persists throughout life. The bile pigment is derived from hemoglobin, but is free from iron. Tibbles thinks this pigment is split off from the hemoglobin, while the iron-bearing nucleoproteins are stored in the cells of the liver.

Considerable variations in professional opinion have arisen as to whether inorganic iron given as a drug for the cure of anemia and chlorosis is absorbed. Von Noorden and others believe that inorganic iron is absorbed and they hold that it is very efficient in the treatment of these maladies. Hamburger and Morden, on the other hand, believe that little or none of the inorganic preparations of iron is absorbed from the alimentary canal. Bunge believes that iron is of therapeutic value in the treatment of anemia and chlorosis. As Tibbles puts it: "Chlorosis is attended by considerable fermentation in the alimentary tract, whereby much sulphuretted hydrogen is evolved, and this gas fixes and prevents the absorption of organic compounds in the food which are normally made use of in the manufacture of hemoglobin." Should there be an excess of inorganic iron present, a large proportion of the sulphuretted hydrogen evolved will combine with such iron to form sulphid, and in this manner protect the organic iron combinations from destruction by the hydrogen sulphid (H_2S). If a condition arises wherein the blood is deficient in iron it will scarcely be possible or practicable to make good such deficiency by ordering inorganic salts in the food. There are very few foods which contain much inorganic iron, although Stockman and von Noorden believe that the inorganic iron contained in the food is absorbed and utilized in the production of hemoglobin. If for any reason the food is deficient in iron, it necessarily leads to a condition of anemia, which conclusion is supported by various experimental observations. It is known that the blood of dogs fed with bread contains less iron than the blood of the same animals when they are fed upon meat; or even children, when they receive only the same proportion of iron per kilogram of body weight as is necessary for an adult. These tend to become anemic.

Sulphur Salts.—Sulphur is present in foodstuffs almost entirely in organic combination, chiefly in proteins. The amount present varies considerably, as shown in Volume II, Chapter IX, page 272. Sulphates are derived from sulphur contained principally in fibrin, egg albumin, the casein of milk, and from such vegetables as corn, turnips, cauliflower and asparagus. The knowledge at the present time of the advantages

or otherwise of an increase or diminution of sulphur in the food is wanting. Where food prepared with so-called alum baking powder is eaten, considerable sulphate may appear in the urine from this source.

The inorganic constituents of food are of importance from the point of view, not alone of the individual ingredients, but of their relations to one another as well. As we have seen, even such elements as sodium and potassium, or calcium and magnesium, that are closely related in chemical properties, are not interchangeable in the animal economy, and, moreover, in some physiological functions are actually antagonistic(20). On the other hand, in some instances certain elements do to a degree replace other elements, as, for example, the sparing influence of calcium on iron metabolism as a result of which an abundance of calcium renders less the amount of iron necessary to maintain iron equilibrium.

Acid-forming and Base-forming Elements of Diet.—Another important relation is that of the acid-forming and base-forming elements of the diet. It appears important that the base-forming elements of the food should be sufficiently abundant, largely, if not wholly, to neutralize the acids formed in catabolism, since otherwise there is a tendency to the production of a condition of acidosis, with the withdrawal of fixed alkalies from the blood and tissues and an increased fixation of ammonium salts whereby the ammonium is not transformed into urea. While it is not absolutely demonstrated that these conditions are immediately productive of disease, it must be regarded as physiologically wrong for man and correspondingly disadvantageous. Moreover, it is quite likely that in certain pathological conditions (*see* Gout, Volume III, Chapter XII) the lack of base-forming elements is actually harmful. Sherman gives the following tables:

FOODS IN WHICH ACID-FORMING ELEMENTS PREDOMINATE

	Estimated excess acid-forming elements equivalent to c.c. normal acid per 100 calories
Beef, free from visible fat	10
Eggs	9
Round steak	6.7
Oatmeal	3.2
Wheat flour	2.7
Wheat, entire grain	2.6
Rice	2.4
Bacon	1.0
Corn, entire grain (high protein)	0.1

FOODS IN WHICH BASE-FORMING ELEMENTS PREDOMINATE

	Estimated excess base-forming elements equivalent to c.c. normal alkali per 100 calories
Celery	40
Cabbage	10–13.6
Potatoes	9–12
Prunes	7.9
Turnips	6.6–12.5
Apples	5
Milk	3.3
Beans	2.9– 6.8
Peas	1.9
Corn, entire grain (low protein)	0.8

Starch, sugars, fats and oils do not ordinarily contain acid- or base-forming elements.

Résumé.—The older view of Wright(21), as to the relation of the diet to scurvy, is probably correct, so far as concerns its following a withholding of a base-yielding diet, but, in view of the recent works on vitamines, it appears that it is not the mere absence of bases but of vitamines that is the causative factor.

From the foregoing pages, the reader is able to grasp the great importance of the functions of the mineral elements in the processes of metabolism. Viewing their nature and importance, it is at once obvious that life could not endure if its complex mineral requirements were not automatically and constantly maintained in a proper adjustment.

While highly developed processes of food manufacture and efficient world-wide transportation facilities give us the greatest opportunities for correct dietetics, yet there are important facts bearing on the relation of food materials and the metabolism of mineral nutrients which open the way to greater injudiciousness and positive abuse in dietetics than could have been possible in our more primitive days. The net result emphasizes an obligation on our part to prepare a defense of knowledge against the misfortunes of plenteous prosperity. In order to emphasize sufficiently the importance of *mineral metabolism* in the processes of nutrition just considered in the preceding pages, we will outline briefly some of the functions of the mineral elements in animal metabolism:

As bearers of electricity the mineral elements dominate the whole course of metabolism.

They conduct nerve impulses, and play a leading rôle in the general process of cell stimulation.

They govern the contraction of the muscles, including those of the heart.

They compose the central agency for the maintenance of neutrality in the blood.

They enter into the composition of every living cell.

They compose supporting structures.

They assist in the coördination of the digestive processes.

They activate enzymes, and through their control of the chemical reaction of the blood and tissues they govern enzyme action.

They unite with injurious products of metabolism and render them harmless or useful.

As catalyzers they may alter the speed of reactions, and the rate of metabolism generally, as measured by oxygen consumption.

Through their effects on osmotic pressure they govern the movement of liquids, and maintain the proper liquid contents of the tissues.

Through their control of the imbibition of water by the colloids they govern absorption and secretion.

Through their control of the affinity of the blood for gases they govern respiration.

Finally, they control the state of solution, precipitation, mechanical aggregation, chemical association and ionization of the colloids which compose living tissue.

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CHAPTER XII

DIET IN HEALTH

WINFIELD S. HALL, PH.D., M.D.

The destiny of nations depends upon the character of their diet.

Dietotherapy—General Principles: Amount of Food Required; Distribution of Meals; Composition of Meals; Influence of Diet on Constitution and Health; Influence of Diet on Character; Influence of Diet on Races; Occupation and Diet; Climate and Diet.
Diet Studies: Students' Clubs; Mechanics and Laborers; Standard and Actual Dietaries Compared; Negroes and Poor Mexicans.
Use of Alcohol.
Diet in Tropical Climates: General Considerations; Fruits and Vegetables; Milk; Meats; Sweets; Diet and Disease; Conclusions.
Alcohol and Beverages in the Tropics.

DIETOTHERAPY—GENERAL PRINCIPLES

Dietotherapy is the proper application of suitable food elements to secure a well-balanced alimentation necessary for the preservation of health and the maintenance of bodily strength and energy, or for their restoration during convalescence after having been impaired by disease. It goes without saying that the value of foods in health must be understood in order properly to appreciate their relative dietetic value in disease.

When studying "The Chemical Constituents of the Body and of Foods" (Volume I, Chapter II), we learned that the human organism is composed of some twenty different universally distributed *chemical elements,* of which the following are most essential: C, H, O, N, S, P, Cl, Na, K, Fe, and Mag, combined in the most complex molecules, some of which contain many hundreds, even thousands, of atoms. We also learned, when studying the "Characters of the Proximate Principles of

Foods" (Volume I, Chapter III), that the chemical composition of the human body is not always an adequate guide to the selection of the essential food elements, though it is an indisputable fact that food that is to nourish an infant's body and sustain it through childhood and puberty must contain these elements. However, it is quite impossible to feed human beings upon chemical elements—to be useful these must be furnished in certain suitable combinations. The table in Volume I, Chapter II, graphically shows the composition of foods. Many of these compounds during the process of digestion and assimilation (Volume I, Chapter VII) are transformed into other compounds which are peculiar to the human body. Even when food material has been adapted to the needs of the body by digestion, it still undergoes further chemical modification before it can be taken up by the cells for their repair, or stored by them, or, by contact with them, be transformed into heat or muscular power.

Thus we see that the human economy requires foods similar in composition to its own substance for growth, development and repair, while it needs fuel foods from which to produce active energy for the work of the body. We have already studied these two phases of body requirements—growth and repair on one side, and work on the other—and find that they make the basis for the classification of foods, as outlined in Volume I, Chapter IX.

Man is an omnivorous animal and can subsist on either animal or vegetable foodstuffs, and derive force and bodily heat from any of them, and, as the body soon adapts itself to its food, very few rules need be formulated. People in the upper walks of life, as a rule, consume more protein and ingest less carbohydrates than do the working classes. The dietaries of public institutions are more liberal with allowances of carbohydrate foods than with protein, on account of economic advantages, but, as stated elsewhere (Volume II, Chapter IX), the protein from vegetables, especially from beans, peas or lentils, can be secured at very reasonable prices and ought to be more universally used, especially when the prices of meats are prohibitive.

Amount of Food Required.—The amount of food necessary for a healthy individual depends upon his age, the amount of muscular activity he expends, the climate (or the weather), and certain other factors, such as the activity of one or more of the ductless glands, as well as on certain indefinite and little understood factors which we group together as "inherited." All physicians called upon to treat disorders incident to childhood are well aware of the enormous appetites of normal children who are active; but

they sometimes lose sight of the fact that the dosage of milk, which is accepted for a six-months' child, is for *the average hospital child* and not for the normal, healthy, active child, which would grow faster on a more liberal allowance of food. Students of dietetics understand that what is needed during hot weather is sufficient food with a liberal allowance of water to counteract the heat liberated in burning the food. The value of peppers and other condiments in the tropics is that, given water enough, perspiration is stimulated and the more it is stimulated the more rapidly the body is cooled.

The Relation of Height to Weight.—This is by no means a fixed ratio, as considerable variations may exist without indication of disease; on the other hand, any great disparity, other things being equal, shows that the *balance* of nutrition is disturbed, and in consequence the chances for longevity are lessened. Height is qualified by the adjectives: dwarfish, short, medium, tall; while the patient is described, from the weight point, as emaciated, thin, spare, medium, stout or obese. Insurance companies have adopted a general ratio of height to weight for different ages—with a minimum, average and maximum weight—which is graphically illustrated in the table on pp. 364-5. Changes in body weight varying from the normal, form, in most instances, a reliable index to the tendency of the malady; progressive loss indicates an advance of the disease, while progressive increase in weight suggests a lessened activity of the disease. As a rule, individuals of moderate height and weight are best adapted to pass successfully through the ordinary trials of life and the extraordinary ordeals of disease, but the thin, "wiry" person may accomplish an enormous amount of work without excessive fatigue, and emerge triumphantly from a severe attack of illness. On the other hand, there are stout, hale and hearty individuals who refuse to grow thin, be worn out, or to degenerate, but who hang on to life in spite of serious, acute or debilitating disease.

The food requirements for adults living under similar environments vary with the weight of the individual. The larger the body the more food will be required (*see* Volume II, Chapter IX), for, as has already been pointed out, the extent of the body surface influences in a measure the radiation of heat or energy, and the larger the surface the more food per kilo will be consumed. This has been tested experimentally, both in man and animals, and the conclusions reached are that the *food must be proportional to the weight of the body* and *area of body surface.*

The dissipation of heat varies with the condition of rest or work. While at rest an individual weighing 154 pounds (70 kilos) during a

TABLE OF STANDARD HEIGHT AND WEIGHT AT VARYING AGES

(*Based upon an analysis of 74,162 accepted male applicants for life insurance, as reported to the Association of Life Insurance Medical Directors, 1897*)

(The figures above and below are 20 per cent over and under the average)

Ages................	15–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69
	96	100	102	105	106	107	107	107	105	
5 feet 0 inches.......	120	125	128	131	133	134	134	134	131	
	144	154	154	157	160	161	161	161	157	
	98	101	103	105	107	109	109	109	107	
5 " 1 "	122	126	129	131	134	136	136	136	134	
	146	151	155	157	161	163	163	163	161	
	99	102	105	106	109	110	110	110	110	
5 " 2 "	124	128	131	133	136	138	138	138	137	
	149	154	157	160	163	166	166	166	164	
	102	105	107	109	111	113	113	113	112	112
5 " 3 "	127	131	134	136	139	141	141	141	140	140
	152	157	161	163	167	169	169	169	168	168
	105	108	110	112	114	115	116	116	115	114
5 " 4 "	131	135	138	140	143	144	145	145	144	143
	157	162	166	168	172	173	174	174	173	172
	107	110	113	114	117	118	119	119	118	118
5 " 5 "	134	138	141	143	146	147	149	149	148	147
	161	166	169	172	175	176	179	179	178	176
	110	114	116	118	120	121	122	122	122	121
5 " 6 "	138	142	145	147	150	151	153	153	153	151
	166	170	174	176	180	181	184	184	184	181
	114	118	120	122	124	125	126	126	126	125
5 " 7 "	142	147	150	152	155	156	158	158	158	156
	170	176	180	182	186	187	190	190	190	187
	117	121	123	126	128	129	130	130	130	130
5 " 8 "	146	151	154	157	160	161	163	163	163	162
	175	181	185	188	192	193	196	196	196	194
	120	124	127	130	132	133	134	134	134	134
5 " 9 "	150	155	159	162	165	166	167	168	168	168
	180	186	191	194	198	199	200	202	202	202
	123	127	131	134	136	137	138	138	139	139
5 " 10 "	154	159	164	167	170	171	172	173	174	174
	185	191	197	200	204	205	206	208	209	209
	127	131	135	138	140	142	142	142	144	144
5 " 11 "	159	164	169	173	175	177	177	178	180	180
	191	197	203	208	210	212	212	214	216	216

TABLE OF STANDARD HEIGHT AND WEIGHT AT VARYING AGES—*Con.*

Ages	15–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69
	132	136	140	143	144	146	146	146	148	148
6 " 0 inches	165	170	175	179	180	183	182	183	185	185
	198	204	210	215	216	220	218	220	222	222
	136	142	145	148	149	151	150	151	151	151
6 " 1 "	170	177	181	185	186	189	188	189	189	189
	204	212	217	222	223	227	226	227	227	227
	141	147	150	154	155	157	155	155	154	154
6 " 2 "	176	184	188	192	194	196	194	194	192	192
	211	221	226	230	233	235	233	233	230	230

period of twenty-four hours gives off 15 cubic feet of CO_2. Since 1 cubic foot of CO_2 produced by combustion involves an expenditure of heat equivalent to 160 foot tons of energy, it follows that 15 x 160 (2,400) foot tons are required for the maintenance of normal temperature and the ordinary functions of the organism while the body is at rest. And since one calorie equals 1.54 foot tons of energy, 2,400 foot tons are equivalent to about 1,550 calories, *i.e.,* 22.3 calories for each kilo of body weight. Playfair and Parkes conducted studies to determine the minimum food requirement and concluded that this amount of heat and energy would be furnished from the combustion in the body of dry albumin, fat and carbohydrate—barely yielding the "sustenance diet."

Later investigations show that the amount of food required to supply the heat expended per kilo of body weight by an adult under various conditions, from absolute rest to strenuous activity or laborious work, ranges as follows:

TABLE OF ADULT REQUIREMENTS PER KILO

For sustenance only	23.0	calories
During rest in bed	25.0	"
Sedentary occupations	35.0	"
Very light work	40.0	"
Moderate work	42.0	"
Laborious work	60.0	"
Extra strenuous labor	120.0	"

A normal individual free from digestive disturbances and physically fit, who ingests a well-balanced ration scientifically calculated according to his age, height, weight and area of body surface will, without question, maintain the normal ratio of weight for his age and height.

When the normal amount of food is consumed by a healthy individual, other things being equal, physiological growth will occur, but if food is ingested in too large quantities, or if the body is inactive, food above the actual requirements will be stored in the form of fat. Lack of exercise in such a case will tend to stoutness, for the "contented" person, as a rule, moves along the lines of least resistance; his mind and muscles are oftener at ease, and so he burns less of his food and stores more than an active, energetic person. "Laugh and grow fat" is a physiologic truth, but, on the other hand, many adipose persons are impetuous, impatient and discontented, and, again, many are strenuously active. In such cases one of two things has happened: either they have inherited a type of metabolism which is not normal for the race, or something is wrong with the internal secretory organs, especially the pituitary, the thyroid, or the sex glands. The thin, lean, lanky individual is one who eats too little or exercises too much for the diet consumed, is nervous from some ductless gland disorder, or is just naturally "skinny."

Distribution of Meals.—The early founders of this country, like the ancient Greeks, partook of three meals daily: two light repasts, *breakfast* in the early morning, and *supper* at the close of the day; and the principal meal, *dinner,* at mid-day, usually followed by an hour or two of rest. This custom still prevails in most agricultural districts. In the busy metropolitan centers the needs of modern activity have changed the distribution of meals, and the full mid-day repast is now replaced by a light lunch, which allows, without the rest of the old régime, intellectual or muscular work almost immediately following, but which necessitates a substantial meal or dinner at six o'clock in the evening, several hours before retiring. This arrangement of meals, without being absolutely hygienic, appears fairly suitable. According to Gautier(1), the well-to-do English families of what is termed the middle class, and the German families in easy circumstances, have breakfast at nine o'clock, dinner at two (this is the principal meal), tea at five, consisting of tea, coffee, cocoa or beer, with bread, butter and cheese or ham, and lastly a light supper just before retiring.

Composition of Meals.—The composition of the meals, as pointed out in Volume II, Chapter VII, should vary with the nature of the occupation. A light but sufficient repast at the noon hour suits those who are occupied chiefly with office work or business activities; but for the workman or peasant who from six or seven o'clock in the morning to mid-day or one o'clock, has been engaged in strenuous, tiring exercise, the noon repast should be sufficiently liberal to allow him, not only to make good his losses, but also to provide him afresh with expendable energy. According to

Pavlov, it is necessary to normal digestion, that food should be taken at regular intervals. He cautions against the ingestion of too large a meal at one time, which overloads the stomach and hinders digestion.

Recent physiological experiments emphasize the fact that meat remains in the stomach several minutes (15 to 45) before pepsin is secreted, which, without doubt, is a provision of Nature to allow the ptyalin of the saliva to transform some of the cooked starches into sugar, as well as to make an alkaline coating to the bolus of starchy food. Later the acidity of the gastric juice produced must be sufficient to excite, in the duodenum, the pancreatic and intestinal secretions.

The inhabitants of the Polar regions subsist almost entirely upon food from the animal kingdom, which is rich in fat, the dwellers on the borders of the Frozen Sea—Laplanders and Greenlanders—feeding almost entirely on fish and the flesh and fat of seals, probably as much from instinct as from the impossibility of securing other food. The Arab, on the contrary, is satisfied with a few dates and a little couscous(2), the latter a kind of food used by the natives of Northern Africa, made from flour cooked with flesh and other ingredients, as the leaves of baobab. The Italian finds his macaroni quite sufficient, while the inhabitants of the intermediate zone use a ration well balanced with nitrogenous, fatty and carbohydrate foods.

The annual consumption of meats in different countries may be of interest to the reader. In the United States the annual consumption per capita per annum is 172 pounds, or about one-half a pound per day for each individual, man, woman or child. As many women and children consume very little, there must, therefore, be a large number of men who ingest enormous quantities of meat. Gautier(1) points out that the Englishman consumes 130 pounds per capita; the Frenchman's annual consumption of meat is 86 pounds; while the dweller in the City of Paris consumes 207 pounds; the average consumption per capita in the larger towns in France is 158 pounds, while the peasantry can scarcely afford 42 pounds per annum. According to this figure, the peasantry are compelled to subsist on about 26 grams of fresh meat per meal. The Australian is the greatest meat consumer of all, the annual consumption per capita being in the neighborhood of 240 pounds.

When studying the subject of "Protein and Nutrition,"[1] we found that the lowest protein demand was about 65 grams per day; the quantity that the French peasant consumes, therefore, is insufficient for the workman and laborer who have most need of it. Gautier states that "even at the

[1] *See* Volume II, Chapter VII.

present time meat is only, so to speak, a relish for the countryman. A townsman, on the other hand, generally eats more meat than agrees with him. We have seen that in Paris the alimentary principles of animal origin exceed 480 grams per day, 260 grams of which are meat, and this figure must at least be doubled for many unemployed townsmen."

As the opium smoker feels the need of the drug when he does not have it, so the individual who accustoms himself to partaking excessively of animal foods misses them when he fails to consume the usual excessive quantity. In contrast with the large meat eater of easy circumstances, the peasant does not eat enough meat. His dietary is too exclusively vegetable and forces upon him a regular digestion of dishes of great volume—potatoes, green vegetables, fruits, etc.—which bring him only an insufficient supply of nitrogen. In this class it is common to find gastralgia, dyspepsia and enteritis. This unbalanced diet is fortunately offset, to a large extent, by strenuous exercise in the open air, ventilated, isolated, sunny dwellings, good rest at night, and sometimes in the summer months a siesta at noonday, with the minimum of inducements to intemperance and vices which beset the city dweller; but in spite of the great and many advantages of living in the open, the average life of the countryman, according to Gautier(1), is shorter than that of a man in the middle class in the towns. Gautier's statement may be correct for French peasants, but the agricultural classes in this country outlive by many years the working men of the cities.

Influence of Diet on Constitution and Health.—The influence of standard dietaries on constitution and health has been referred to already when considering the subject of "Protein and Nutrition." There was outlined the standard dietary for different occupations, founded principally on the experiments of Chittenden and other workers in this field of research. This dietary provides for the physiological needs and losses of the system in quantities and kinds of foods best suited for a healthy adult whether engaged in strenuous exercise or living a more or less inactive life. On the other hand, a careful examination of the tables in Volume II, Chapter V, will show the quantity of protein, fat and carbohydrate necessary to provide for the requirements of calorification, which varies greatly according to the temperature of the surrounding atmosphere. Gautier estimates that a Frenchman, in relative repose, needs from 80 to 82 grams of protein (one-half of which should be furnished by animal food and the other half by vegetable food). He considers this sufficient, and if the daily diet is increased, as often happens in Paris, to 102 grams of protein, the difference of 20 or

more grams constitutes a reserve supply. The day laborer who lives from hand to mouth, for economic reasons, receives only the necessary amount of food for daily wear and tear, and, as a consequence, is constantly in danger of a deficiency. If he happens to be called upon to carry out a strenuous task, if any of the bodily functions be slightly disturbed, and if his sleep is not sufficient for repair, these causes, and many others besides, by diminishing the receipts or increasing the expenditures, will augment the deficiency, and if there are no storage reserves to meet this condition, it will have to be supplied by combustion of the substance of the organs. Henceforth, a part of the mechanical work, or even the maintenance of animal temperature, will be affected. If the store of fats is exhausted, the bodily functions will destroy some portion of the proteins of the tissues in place of the sugars or the defaulting fats. In order to prevent such deficiencies and losses—and not to be driven to heat the house by burning the furniture—the system must have a reserve at its disposal, namely that created by ingesting slightly more at each meal than is required for body metabolism. The old adage, that we should "lay by something for a rainy day," is as true in nutrition as in finance. It is necessary that the gain of to-day should suffice to compensate for the loss of to-morrow, and that, by means of a sufficient surplus beyond the daily requisite allowance, it should be possible to provide not alone for mobile equilibrium, but to prepare the system so that the losses will never exceed the supply. This is especially important with reference to proteins and organic mineral salts.

From the above it may be seen how important it is to eat slightly more than the minimum requisite daily ration. At the same time it must be borne in mind that this excess may in turn become *dangerous* if carried beyond certain limits. The proteins, if not utilized by means of mechanical labor, by powerful work of the lungs and skin, by a sufficient combustion and normal radiation of heat, will, when all their waste accumulates in the organism, accentuate a predisposition to obesity, arthritis, and diseases of the skin, and augment visceral congestion and neuropathic conditions.

A well-balanced dietary for the working man engaged in strenuous occupations in the open air would be a dangerous ration for the sedentary citizen who expends but little muscular energy, or for the artist and student who devote themselves entirely to intellectual occupation(3). In young people during adolescence, or in those individuals whose organs, whatever be their age, have largely preserved their normal activity, a slight indulgence beyond the normal requirements of a well-balanced dietary will exert no other effect than necessitating a greater activity of the excretory organs—lungs, liver, skin and kidneys. But this will not

apply to those whose constitution or bodily habits are defective to begin with. In such individuals a dietary in excess of actual requirements will daily accentuate decay; hepatic or pulmonary congestion, arteriosclerosis, degenerative conditions of the kidneys and of various other organs will increase, and there will be eventually established, little by little, if not disease, at any rate a predisposition to it(1). It will readily be seen, therefore, that the ingested aliment should be well balanced and in proportion to our needs, and regulated not by natural appetite alone, but by reason, aided, when necessary, by the advice of those who have devoted much time and energy to working out these intricate problems.

Influence of Diet on Character.—The character of individuals is undoubtedly more or less influenced by diet. If a certain alimentation influences the general health by reason of its abundance or insufficiency, why may it not act still more by its nature? It is a universally accepted fact that the most robust, active and aggressive people are great meat eaters. People whose chief subsistence is composed largely of carbohydrate foods—vegetables and fruits—are nearly always peaceful, as, for instance, the inhabitants of Central Asia, with whom rice and vegetables with a little pork or fish form the principal articles of diet(4). We cannot help coupling these facts with the statement previously made that carnivorous animals are generally fierce and savage, while the herbivora, on the contrary, are easy to tame and domesticate. Excessive or exclusive flesh diet plays even a greater rôle than racial peculiarities in influencing the temper of an individual. Gautier(1) is authority for the statement that white (laboratory) rats are manageable and easy to tame as long as they are fed on bread or grain, but when fed on flesh they become snappy and aggressive—given to biting. Liebig relates that a bear kept in a museum at Giessen was a gentle, docile animal when fed exclusively on bread and vegetables, but a few days on animal diet caused it to become fierce and dangerous, even to its keeper.

We may, then, safely adduce the theory that diet influences temperament. An exclusive animal diet makes one more aggressive, pugnacious, determined and self-willed; while an exclusive vegetable diet depletes and enfeebles the violence of temperaments and softens and subdues manners. This fact has long been understood by the founders of religious orders in Europe, India and Asia, who have, accordingly, limited or prohibited the allowance of animal food in the dietary.

In studying the "Processes of Digestion," we learned that vegetable food is less completely assimilated than animal food, imposing greater exertions on the part of the intestine, thereby diverting part of its energy

to the accomplishment of these lower functions; it introduces into the system far less nutrition than meats, and far less of those sapid extractive matters which stimulate the heart, prod the muscle, and augment mechanical energy (1). It is, therefore, plain that an exclusively vegetable diet perceptibly weakens and softens the will. The wolf and wild cat—specimens of the most dangerous carnivorous animals—have been domesticated by a change of diet into docile, peaceable, friendly household pets—*dogs and cats.*

Influence of Diet on Races.—If we accept the theory that diet affects the development of the organs and character, we can hardly deny that it also modifies races. Darwin voiced the opinion that alimentation which creates internal conditions is, with the influence exercised by external conditions and selection, the preponderant cause of the variations observed in animals. Gautier believes that the qualities peculiar to each individual and each race are perceptibly influenced by the continuous action of diet, and that, reciprocally, when habits are contracted and temperaments created by long heredity, a special diet often becomes necessary. He says an Englishman or Dutchman will become weakened on being deprived of meat far more quickly than the Spaniard, Southern Frenchman or Italian, and that the latter races, when fed on the same food, if almost entirely vegetable, will be able to perform much more work than a member of the Northern races. Beyond doubt diet influences the physiological vigor and character of races. As a consequence, it must also have a bearing on intellectual aptitudes.

Occupation and Diet.—We know that a man doing mechanical work requires a dietary abundant in ternary principles—carbohydrates, hydrocarbons and meat, especially the latter. Such a dietary, we have seen, develops muscular force, energy, vigor and even violence, while on the contrary, it is not very favorable to the culture of the artistic or scientific temperament. According to Gautier, those who would give themselves up to speculation and thought, to the exercise of their powers of observation or generalization, the development or expression of their artistic sentiments, the cultivation of the abstract sciences, etc., require bread, green vegetables, ripe fruits, and, for nitrogenous food, 150 to 200 grams (5 to 6 ounces) of meat, fish or poultry per day, eggs, milk and other foods easily digested (rice, carrots, cauliflower, asparagus, mushrooms, a small quantity of potatoes, etc.), and finally a few aromatic condiments, together with a little coffee or tea. Such a diet is far more suitable than one rich in animal proteins and fats, and the more so because those who devote themselves to exercising the mind or imagination generally take insuf-

ficient physical exercise, thus constituting themselves candidates for arthritis, gout, hepatic, cerebral and renal congestions. Such predispositions are often increased by the abuse of coffee or tea, sometimes of alcohol or tobacco, and the desire for condiments which momentarily excite the appetite which sedentary work tends to weaken. For them the dishes to avoid are those which are difficult to digest or which require to be taken in a great quantity, too abundant meats and too starchy vegetables.

For individuals who devote their energies to intellectual research, in whom artistic impressions predominate, the dietary allowance should be that which corresponds to their vocation as well as to the climate in which they live. Beyond doubt, all brain work consumes energy corresponding to the effort expended. Moritz Schiff has "demonstrated that every impression heats the brain and the organism and causes as a consequence an expenditure of energy." Physiologists have pointed out the fact that intellectual fatigue does not increase the quantity of the total urinary nitrogen and consequently the amount of protein broken up or the combustion of fats(5) or even the amount of phosphorus excreted in a given period of time. When considering the subject of "Hygiene of Eating," we emphasized the point that intellectual effort should never be undertaken immediately after or following a large meal, when the organs of digestion are most active and require that the blood should not flow to the brain, but to the stomach. During sleep, the destruction of the nitrogenous principles of our tissues does not appear to vary; but that of the fatty bodies becomes greatly enfeebled without the amount of oxygen absorbed always diminishing in proportion. There is often an accumulation of oxygen in the system during the night's rest, especially in the case of young children(6).

Climate and Diet.—Climate and season beyond question have an important bearing on the necessary dietary. In cold climates and seasons more heat is radiated from the body, and the loss from breathing is much greater; therefore a richer dietary for the same amount of work becomes necessary, and, similarly, a poorer dietary will suffice in a warm country. As will be seen further on in this chapter, when considering diet in the tropics, it is obvious that more heat is radiated by evaporation of the water from the lungs or in the form of perspiration in hot climates, which diminishes the proportion of energy otherwise capable of being transformed into muscular exertion. It is apparent, therefore, that this loss by cooling is slight, and the individual will be able to discharge his functions and allotted tasks equally well on a smaller diet. Gautier records an instance where Catalonians lived on a dietary which provided them with no more than 1,900 to 2,000 calories, yet they were none the less good-

tempered, healthy and muscular, and capable of executing a great amount of work. This author also quotes Maurel of Toulouse, who has done some interesting research work along this line(7). Below is inserted a table worked out by Prof. Maurel for the maintenance allowance in hot seasons and hot countries, cold seasons and cold countries, and finally the intermediate climates for normal individuals from twenty to thirty:

MAINTENANCE ALLOWANCE ACCORDING TO CLIMATES

Climate and Seasons	Number of Calories per kilogram	Calories per 24 Hours		
		Man weighing 60 kilograms	Man weighing 70 kilograms	Man weighing 80 kilograms
Hot season of hot countries..	30	1800	2100	2400
Cold season of hot countries and summer of temperate countries..........	35	3100	2450	2800
Intermediate season of temperate countries and summer of cold countries.....	40	2400	2800	3200
Cold season of temperate countries and intermediate season of cold countries...	45	2700	3150	3600
Cold season of cold countries	50	3000	3500	4000

In the beginning of this chapter we referred to diet in cold climates and to the enormous amount of meats and fats consumed by the inhabitants of the Polar and Arctic regions. Wherever muscular exercise becomes a necessity, animal food should form a large part of the dietary, and the allowance should be relatively more liberal in proportion to the degree of work to be performed. Explorers have given us the advantage of their experiences in the Arctic regions in allowing a certain proportion of alcoholic beverages with meals(8). During a cold season or in the Arctic regions the question of resisting cold is a vital one. We have seen that the ingestion of large quantities of fat and flesh, with this object in view, is of the utmost importance. The Eskimo and Greenlander when exposed to the cold will drink and relish several pints of fish oil per day. On the other hand, in tropical climates and hot seasons, fats, the great producers of heat, should naturally form only a small part of the daily ration, and soft drinks, lemonades, etc., should take their place. This point will be further elaborated on in the section on "Foods in Tropical Countries."

DIET STUDIES

The dietaries of the inhabitants of the United States vary with different classes and in different sections of the country. Numerous investigations upon nutrition have been made in the various parts of the United States under the auspices of the Department of Agriculture(9). The table on page 249 shows the dietaries of various classes of laborers, students and professional men. This table contains facts and figures with reference to the diet of students' clubs and colleges and contrasts them with the diet of professional men and mechanics. It must be borne in mind that the dietaries contained in this table(10), giving the protein, fat, carbohydrate and energy content of the various standard diets and of the diet in the principal universities and for mechanics and other day laborers, does not portray accurately the dietary of the people of the different sections of the country. It is evident from the facts and figures in these statistics that people eat what their markets provide, except when poverty prevents purchasing. For instance, the family of a sewing woman in New York City(11) averaged for one person a day:

DIETARY OF A POOR PERSON IN NEW YORK CITY, SHOWING THE FOOD ELEMENTS AND CALORIES

	Protein	Fat	Carbo-hydrate	Energy Equivalent
	Grams	Grams	Grams	Calories
Animal food	26	34	15	485
Vegetable food	31	7	222	1,100
Total	57	41	237	1,585

Or a total of 57 grams of protein and 1,585 calories, this being less than a mere subsistence. The articles of food consumed by this family were beef shank, pork chops, sardines, eggs, butter, milk, barley, wheat flour, rye bread, wheat bread, rolls, cakes, crackers, sugar, beans, potatoes, radishes, rhubarb and tomatoes. The principal quantities of animal food consumed were in the form of eggs and milk; of carbohydrate, bread, sugar, potatoes and canned tomatoes.

Students' Clubs.—The table below outlines the various articles of food comprising the dietary of students' clubs in four different states, as mentioned in the table on page 249, Volume II, Chapter IX.

WEIGHT OF DIFFERENT CLASSES OF FOOD PURCHASED PER MAN PER DAY(16)

	Tennessee	Missouri	Connecticut	Maine
	Grams	Grams	Grams	Grams
Beef, veal, mutton	187	160	245	231
Pork	89	113	91	98
Poultry	28	12	6	100
Fish	12	6	24	77
Eggs	32	55	35	53
Butter	39	27	60	52
Cheese	7	7	...	...
Milk	97	680	457	910
Buttermilk	108	...	...	...
Cereals, sugar, etc	564	524	361	835
Vegetables	250	266	189	530
Fruits	50	51	89	48

A study of this table reveals the fact that the greatest quantities of animal foods were consumed by the students' clubs in Maine, Missouri and Connecticut, and the least in Tennessee. The consumption of carbohydrate foods was largest in Maine and least in Connecticut. It will be noticed also that the students in Connecticut and Maine consumed a larger proportion of beef than was used by the students in Tennessee or Missouri. In the latter state the students consumed a noticeably large amount of pork. While in Maine poultry and fish comprised a large part of the animal food, these were little used in the colleges in Tennessee and Missouri. Milk formed a conspicuous percentage of the diet in the schools of Missouri, Connecticut and Maine, while in Tennessee it was used sparingly. The dietary of the student clubs in Maine seems to be much more generous in all respects than the others. In Tennessee the average of five student clubs was 92 grams of protein, yielding 3,545 calories of energy; 38 per cent of the food value was obtained from animal food and 62 per cent from vegetable food. In Missouri the average of three student clubs was 96 grams of protein, the menu yielded 3,560 calories of energy, and the food value was about equally divided between the animal and vegetable kingdoms. In Connecticut, of 5 student clubs the average was 106 grams of protein, the ration yielding 3,280 calories of energy, 53 per cent of which was furnished by animal food and 47 by vegetable food. In Maine, the average of 5 student clubs was 121 grams of protein, the menu yielding 4,269 calories of energy, 40 per cent of which was furnished by animal food and 60 per cent by vegetable food. Although these dietaries do not portray the actual dietaries of the people in the sections of the country

where these schools are located, yet they may be accepted as an approximate criterion of the usual dietary of the inhabitants of the various sections.

Mechanics and Laborers.—The dietary of most mechanics in the United States affords them from 100 to 150 grams of protein, and yields from 3,000 to 5,000 calories of energy. A list of occupations requiring a great expenditure of energy and the necessary energy required expressed in calories will be found by referring to previous pages in this chapter. It is not, after all, such a formidable task to reckon the caloric value of a meal. For instance, take the principal meal (dinner) of a laborer or mechanic: roast beef, 100 calories; bread, 150 calories; butter, 150 calories; rice, 128 calories; baked potato, 100 calories; bread pudding, 128 calories; sugar and cream with coffee, 100 calories; total, 960 calories, about one-third of the day's requirements. A meal of this composition is over-rich in protein, but the balance would be restored by lack of protein and an excess of green vegetables and fruits at the other two meals. It will be taken into consideration that the ordinary portions of these substantial foods average about 100 calories. When extra strenuous effort is put forth in an occupation, the portions of bread and potatoes, butter and rice can be increased and easily raise the meal to the energy requirement without adding to the main protein ration, whatever it may be—meat, cheese, chicken or fish. If a laborer has been subjected to strenuous exercise and is hungry, allow him to fill up on non-protein elements of the meal, help him to more potatoes and vegetables or simple pudding, instead of increasing the animal foods.

It has been found in the South that cornbread and molasses will furnish the necessary energy to carry a negro through a cold day. If he works hard, he will burn it up completely, and there will be no ashes as would be the case if he overate of meat or other protein. Late researches tend to prove that the protein elements can be stored, at least for a short period of time, in the tissues; but such a storage is more or less dangerous from the extra strain put on the liver and kidneys to excrete the waste. Carbonaceous foods—sugar, starches and fats—can be stored in the form of tissue fats.

The average human body weighing 154 pounds should have about six-tenths of its heat or fuel units supplied from carbohydrates, sugar, potatoes, bread, cereals and vegetables; three-tenths should be supplied by fats, butter, oils, cream or meat fats—the last being the least desirable form in which this element may be supplied. These energy or fuel foods should be increased in quantity in proportion to the energy expended in strenuous exercise or in the performance of hard work.

It has always been recognized by scientific men that the allowance of food should be in proportion to the work the body is expected to do. Playfair(12), who has given this subject a great deal of attention, has worked out a table with the corresponding amounts of matter and energy in grams and calories, estimated by Rubner's factors.

PLAYFAIR'S TABLE OF REQUIREMENTS FOR WORK

Subject and Condition	Protein, Ozs.	Fat, Ozs.	Carbohydrates, Ozs.	Salts, Ozs.	Dynamic Value, Ft. Tn.	Protein, Gms.	Fat, Gms.	Carbohydrates, Gms.	Salts, Gms.	Energy, Calories
Subsistence diet......	2.230	.840	11.69	.....	2,453	63.25	22.0	330	.....	1,820
Moderate work.......	4.075	1.557	18.80	1.963	4,072	115.00	44.0	534	14.00	3,070
Soldiers: During peace	4.215	1.397	18.69	.714	4,026	120.00	40.0	510	19.25	3,037
Infantry in the field.	5.410	2.410	17.92	.680	4,458	154.00	68.0	610	19.07	3,374
Royal Engineers in the field.........	5.080	2.910	22.25	.930	5,232	144.00	82.5	610	26.36	3,858
English sailors........	5.000	2.370	14.39	.....	3,911	142.00	65.0	410	.....	3,067
Navy...............	5.640	2.340	20.41	.....	4,839	160.00	67.0	578	.....	3,650
Prisoners: Under 7 days	1.800	.480	10.71	.....	1,938	51.00	14.0	304	.....	1,626
Under 21 days.....	2.448	.608	14.80	.....	2,650	68.00	17.0	425	.....	2,179
Light labor........	3.508	.315	16.72	1.715	3,577	100.00	9.0	470	50.00	2,420
Industrial labor....	3.710	1.562	17.31	1.616	3,787	105.00	44.0	495	46.00	2,870
Hard labor........	4.075	1.557	18.80	1.963	4,072	116.00	44.0	534	14.00	3,075
Undergoing punishment............	1.296	.256	8.16	.368	1,541	36.00	7.1	230	10.60	1,154

Many physiologic investigators have devoted considerable time and research to determine the alimentation consumed by individuals who were allowed a "free choice of food," and have come to the conclusion that the dietaries having the food value given in Playfair's table would furnish a nutrition that was fairly normal and that the nitrogen balance would be kept in a fair state of equilibrium. The conclusion is that the Playfair dietaries represent fairly well the amount of food required by persons studied in these tables, which we will now compare with the alimentation outlined in the table given on page 270. The list of examples of food consumed is compiled from data collected by Tibbles(13) in Europe, Asia and America, and shows that when Europeans or Americans are free to choose their own food they seldom select what will yield less than 100 grams of protein per diem. When the choice of food rests with the individual (American), he seldom partakes of less than 90 grams of protein per day. In this country there are many thousands of individuals who, from force of circumstances, are necessarily compelled to subsist on a

dietary with a much smaller quantity of protein, because eggs, meat, fish, fowl, milk and cheese are more expensive than bread, potatoes, rice, oatmeal, etc.

Standard and Actual Dietaries Compared.—We will now study the following standard daily dietaries as suggested by Hutchison(14), all containing a high protein content, founded on the investigations by Atwater(15):

DAILY STANDARD DIETARIES

(Food materials furnishing approximately the 0.28 pound = 125 grams of protein and 3,500 calories of energy of the standard for daily dietary of a man of moderate muscular work.)

Food Materials	Amount	Total Organic Matter	Protein	Fats	Carbo-hydrates	Fuel Values
	Ounces	Pounds	Pounds	Pounds	Pounds	Calories
I						
Beef, round steak	13	0.26	0.14	0.12	...	695
Butter	3	0.16	...	0.16	...	680
Potatoes	6	0.17	0.02	...	0.15	320
Bread	22	0.89	0.12	0.02	0.75	1760
	44	1.48	0.28	0.30	0.90	3455
II						
Pork, salt	4	0.21	...	0.21	...	880
Butter	2	0.11	...	0.11	...	450
Beans	16	0.84	0.23	0.02	0.59	1615
Bread	8	0.33	0.04	0.01	0.28	640
	30	1.49	0.27	0.35	0.87	3585
III						
Beef, neck	10	0.19	0.10	0.09	...	550
Butter	1	0.05	...	0.05	...	255
Milk, one pint	16	0.13	0.04	0.04	0.05	325
Potatoes	16	0.17	0.02	...	0.15	320
Oatmeal	4	0.23	0.04	0.02	0.17	460
Bread	16	0.67	0.09	0.02	0.56	1280
Sugar	3	0.19	...	...	0.19	345
	66	1.63	0.29	0.22	1.12	3535
IV						
Beef, upper shoulder	10	0.22	0.09	0.13	...	800
Ham	6	0.19	0.06	0.13	...	650
Eggs, two	3	0.05	0.03	0.02	...	135
Butter	2	0.11	...	0.11	...	450
Milk, one pint	16	0.13	0.04	0.04	0.05	325
Potatoes	12	0.12	0.01	...	0.11	240
Flour	9	0.44	0.05	0.01	0.38	825
Sugar	1	0.06	...	...	0.06	115
	59	1.32	0.28	0.44	0.60	3540

DAILY STANDARD DIETARIES—*Continued*

Food Materials	Amount	Total Organic Matter	Protein	Fats	Carbo-hydrates	Fuel Values
	Ounces	Pounds	Pounds	Pounds	Pounds	Calories
V						
Sausage	4	0.14	0.03	0.11	...	510
Codfish	14	0.07	0.07	...	...	140
Butter	2	0.11	...	0.11	...	450
Milk, one pint	16	0.13	0.04	0.04	0.05	325
Beans	5	0.26	0.07	0.01	0.18	505
Rice	2	0.11	0.01	...	0.10	205
Potatoes	16	0.24	0.01	...	0.23	420
Bread	9	0.33	0.04	0.01	0.28	640
Sugar	3	0.19	...	...	0.19	345
	71	1.58	0.27	0.28	1.03	3540
VI						
Beef	8	0.18	0.08	0.10	...	560
Mackerel, salt	4	0.08	0.04	0.04	...	230
Two eggs	3	0.05	0.03	0.02	...	135
Butter	2½	0.13	...	0.13	...	565
Cheese	1	0.04	0.02	0.02	...	130
Milk, one pint	16	0.13	0.04	0.04	0.05	325
Potatoes	8	0.09	0.01	...	0.08	160
Rice	2	0.11	0.01	...	0.10	205
Bread	9	0.38	0.05	0.01	0.32	720
Sugar	1½	0.69	...	...	0.09	175
	55	1.88	0.28	0.36	0.64	3205

The standard daily dietaries given are constructed from theoretical data taken from Hutchison on this and the preceding page. It will now be interesting to make a comparative study of these dietaries with the composition of ordinary daily dietaries actually consumed by individuals of different countries, of different social rank, following various and sundry occupations. In the table on pages 378-9, modified from Atwater(16), studies are compiled from a large number of actual dietaries.

On careful study of the tables (pages 380-1) of actual dietaries, it will be observed that they conform closely to the ideal standard dietary on the preceding page. Discrepancies of course will be noted here and there. For instance, the diet of the sewing girl in London is altogether insufficient for bodily requirements, while, on the other hand, the diet of some well-to-do American families, bricklayers, and teamsters is needlessly liberal, especially with the protein allowance (compare low protein allowance suggested by Chittenden(17) in his standard dietary table given in Volume II, Chapter VII). Taking the preceding table as a whole, it is gratifying

ACTUAL DIETARIES

Classes	Nutritive Constituents				Potential Energy
	Protein	Fats	Carbo-hydrates	Total	
United States Dietaries	Grams	Grams	Grams	Grams	Calories
Factory operatives, mechanics, etc., Mass.	127	186	531	844	4,428
Glass-blowers, E. Cambridge, Mass......	95	132	481	708	3,590
Factory operatives, dressmakers, clerks, etc., boarding-house.................	114	150	522	786	4,002
Well-to-do private family, Connecticut:					
Food purchased.....................	129	183	467	779	4,146
Food eaten.........................	128	177	466	771	4,082
College students from Northern and Eastern States; boarding club, two dietaries of the same club:					
Food purchased.....................	161	204	680	1,045	5,345
Food eaten.........................	138	184	622	944	4,827
Food purchased.....................	115	163	460	738	3,874
Food eaten.........................	104	136	421	661	3,417
College football team, food eaten........	181	292	557	1,030	5,742
Machinist, Boston, Mass...............	182	254	617	1,053	5,638
Brick-makers, Middletown, Conn........	222	263	758	1,243	6,464
Teamsters, marble-workers, etc., with hard work, Boston, Mass..................	254	363	826	1,443	7,804
Brick-makers, Cambridge, Mass.........	180	365	1,150	1,695	8,848
U. S. Army ration....................	120	161	454	735	3,851
U. S. Navy ration....................	143	184	520	847	4,998
Average of 53 American studies.........	103	138	436	677	3,500
Professional men in America (average of 14 studies).........................	104	125	423	...	3,325
Average of 4 women students' clubs in America............................	101	139	.414	...	3,405
Average of 16 men students' clubs in America............................	105	147	465	...	3,705
Canadian Dietaries					
French Canadians, working people, in Canada............................	109	109	527	745	3,622
French Canadians, factory operatives, mechanics, etc......................	118	204	549	871	4,632
European Dietaries					
Average diet of laborer's family in Edinburgh..............................	107.7	88.4	479.4	675.5	3,228
Chinese dentist's family................	115	113	289	...	2,705
Japanese professional man..............	63	3	481	...	2,258
Malays (professional men)..............	73	30	472	...	2,512
Europeans in Java (professional men)....	100	84	264	...	2,470
University boat crews (average of 7 studies)............................	155	177	440	...	4,085
London, sewing girl, wages 3s. 9d. per week	53	33	316	402	1,820
Leipsic, Germany, factory girl, 5s. per week	52	53	301	406	1,940
England, weaver, time of scarcity.......	60	28	398	486	3,138

ACTUAL DIETARIES—*Continued*

Classes	Nutritive Constituents				Potential Energy
	Protein	Fats	Carbo-hydrates	Total	
European Dietaries—Continued	Grams	Grams	Grams	Grams	Calories
Lombardy, Italy, laborers; diet mostly vegetable	82	40	362	484	2,192
Trappist monk in cloister; very little exercise, vegetable diet	68	11	469	548	2,304
Japan, students	97	16	438	551	2,343
Munich, Germany, university professor, very little exercise	100	100	240	440	2,324
Munich, lawyer	80	125	222	427	2,401
Munich, physician	131	95	327	553	2,762
Leipsic, Germany, painter	87	69	366	522	2,500
Leipsic, Germany, cabinet-maker	77	57	466	600	2,757
England "fully fed" tailors	131	39	525	695	3,053
Munich, Germany, "well-paid" mechanic	151	54	479	684	3,085
Munich, Germany, carpenter	131	68	494	693	3,194
England, "hard-worked" weaver	151	43	622	816	3,569
England, blacksmith	176	71	667	914	4,117
Germany, miners at very severe work	133	113	634	880	4,195
Munich, brick-makers (Italians at contract work)	167	117	675	959	4,641
Munich, brewery laborer, very severe work, exceptional diet	223	113	909	245	5,692
German soldiers, peace footing	114	39	480	633	2,798
German soldiers, war footing	134	58	489	681	3,098
German soldiers, Franco-German War, extraordinary ration	157	285	331	733	4,652
Russian workmen	132	80	583	...	3,675
Swedish workmen (moderate labor)	134	79	523	...	3,436
Swedish workmen (hard labor)	189	110	714	...	4,726

to observe the closeness with which the actual dietaries correspond to the standard. We must not overlook the fact that the standard dietaries such as we have been considering have only a limited range of usefulness. It would not be wise to apply them rigidly in any particular case, since they have been formulated to meet the demands of typical vocations living under well-known and regulated conditions and engaged in occupations calling for only a moderate amount of muscular work. Still they are of value in guiding us to formulate well-balanced rations for persons who have no decided choice in their alimentation, and who are living under fairly uniform regulations—such as soldiers, inmates of prisons, homes and workhouses. Besides, these studies furnish us with standard information by which to regulate well-balanced rations for any collection of individuals.

Col. Melville, in discussing "The Food Requirements for Sustenance and Work"(18), reported before the British Medical Association his studies on the observation of men doing a measured amount of work with a measured quantity of food.

Twenty soldiers walked for periods of five and six days an average of twelve to thirteen miles, carrying their kit, the weight of which averaged 54 pounds (24.5 kilos). The average weight of the men was 141 pounds (64.15 kilos). The expenditure of energy was calculated from Zuntz's factors: For every kilo transported horizontally at the rate of 94 meters (102 yards) per minute the expenditure was 0.0006 calorie; and for every kilo raised 1 meter vertically the expenditure was 0.0075 calorie; whence it was determined that the average expenditure in walking one mile and carrying 54 pounds over an ordinary give-and-take road was 90 calories, and the total daily expenditure in external or mechanical work amounted to 1,034 calories.

According to the above, it will be readily seen that the total energy expended by these men was as follows:

ENERGY EXPENDED BY MARCHING SOLDIERS

(a) Energy spent in sedentary occupation (Zuntz)	2,200	calories
(b) Energy spent in work to camp life, and in playing quoits and football	800	"
(c) Energy spent in walking and carrying load	1,034	"
Total average daily expenditure	4,034	"

The march was done on six days continuously, then one day's rest intervened before the second period of five days' walking completed the work done. The food consumed was as follows:

FOOD CONSUMED BY EACH SOLDIER PER DAY

	First Week	Second Week	Average
Proteins	190 grams	145 grams	168 grams
Carbohydrates	510 "	450 "	480 "
Fat	58 "	110 "	84 "
Calories	3,426 "	3,503 "	3,481 "

Unavoidable waste, 10 per cent: net calorific value, 3,140.

A careful examination of the above tabulation by Melville(19) emphasizes the fact that there was a deficiency of 890 calories in the alimentation.

Negroes and Poor Mexicans.—Atwater and Wood(20) call special attention to the fact that "our dietary is out of balance," and aver that "the one-sidedness is greater in the South than in the North," by which they mean that the ratio between protein and calories is greater than it should be. The table on page 384 gives data with reference to the protein requirement of the diet of both men and women in various occupations. Hoff-

man, in writing on the diet of the Southern negroes(21), emphasizes the point that the negroes of the Southern States subsist on an unvaried diet, consisting either of staple foods of fat, salt pork, corn meal and molasses, and that with them cooking is most primitive. The following from Hoffman's views on the subject is of interest:

The daily fare is prepared in very simple ways. Corn meal is mixed with water and baked on the flat surface of a hoe or griddle. The salt pork is sliced thin and fried until very brown and much of the grease fried out. Molasses from cane or sorghum is added to the fat, making what is known as "sop," which is eaten with the corn bread. Hot water sweetened with molasses is used as a beverage. This is the bill of fare, three times a day during the year, of most of the cabins on the plantations of the "black belt." It is, however, varied at times; thus, collards and turnips are boiled with the bacon, the latter being used with the vegetables to supply fat, "to make it rich." The corn-meal bread is sometimes made into so-called "cracklin bread," and is prepared as follows: A piece of fat bacon is fried until it is brittle; it is then crushed and mixed with corn meal, water, soda and salt and baked in an oven over the fireplace. Occasionally, the negroes may have an opossum. To prepare this for eating it is first put into hot water to help in removing a part of the hair, then covered with hot ashes until the rest of the hair is removed; thereupon it is put in a large pot, surrounded with sweet potatoes, seasoned with red pepper, and baked. One characteristic of the cooking is that all meats are fried or otherwise cooked until they are crisp. Observation among these people reveals the fact that very many of them suffer from indigestion in some form.

Arthur Goss(22), in writing on the dietary standards of the Alabama negroes, makes a comparison of their diet with that of the Mexicans of New Mexico, and the following from his observations is of interest in this connection:

Mexicans of the poorer class raise the greater part of their food, which is almost entirely of vegetable origin. Flour and corn are used, the relative amounts depending upon the amount of money available. If it is necessary to reduce the cost of living to the minimum, as is often the case, more corn and less flour is used.

Probably the next article in amount, and a very important one, is the native bean or "frijole" (Phaseolus sp.), which, together with peas and lentils, is used to supply the protein necessary in the absence of meats and other nitrogenous foods of animal origin.

Another universal article in the Mexican diet is red pepper, or "chili," which, while it constitutes comparatively a rather small proportion by weight of the total food, is still consumed in enormous quantities as compared with the use of such material by the people of the eastern states. Chili is probably used more for its stimulating effect on the digestive organs than for the actual amount of nutrients which it furnishes.

In point of cost, probably the most important article used by the Mexicans not home produced is coffee. Lard is another very important article which is usually purchased, and which is used in considerable quantities. As the vege-

table foods used contain very little fat, it is necessary to increase the amount of this substance by addition from outside sources, usually either lard compound or beef tallow, which are the cheapest forms of fat in this region.

In the houses of the poorer class the cooking is done in an open fireplace, usually located in one corner of the room.

The "tortillas"(23), or cakes made from flour or ground corn, are one of the most generally and extensively used foods. When the tortillas are made from corn, the kernels are first boiled with lime, which softens them. The skin is then usually, though not always, removed, and the grain is ground in a crude stone grinding apparatus, or "metate," consisting of a concave slab of stone and a smaller convex piece, which is held in the hands and which serves as a pestle. The grinding is not rotary, however, as in an ordinary mortar, but up and down, toward and from the body. The corn used is usually a small blue kind, rather soft, which seems to contain somewhat more than the average amount of fat. After the corn has been ground into a mush on the metate, it is patted out in the hands into the tortillas. Corn tortillas are never rolled, as is the case with those made from flour. If flour is used, it is mixed into a dough with water and the cake rolled out from it. The flour used is not ground in the metate, but in the ordinary flouring mills. It is usually of poor quality, coarse and dark colored. After being worked into the proper form, the tortilla is baked on a flat piece of iron, supported directly over the fire in the open fireplace, the iron being first greased with lard. As soon as it is done on one side the tortilla is turned by pressing the moistened fingers against the upper side of it, thus causing it to adhere to the fingers, whereupon it is deftly turned and the opposite side is browned.

The frijoles, or beans, are cooked in small, home-made earthenware pots, and are almost invariably combined with a very liberal proportion of chili and also with a considerable amount of lard.

DAILY DIETARY OF NEGRO FARMER AND POOR MEXICAN

		Protein	Fat	Carbo-hydrate	Calories
		Grams	Grams	Grams	
Negro farmer:	Animal	52	119	65	1585
	Vegetable	40	5	360	3270
Same:	Animal	2	41	...	395
	Vegetable	42	16	372	1845
Same:	Animal	26	74	26	900
	Vegetable	33	11	403	1890
Poor Mexican:	Animal	..	56	...	520
	Vegetable	107	19	713	3540
Same:	Animal	..	61	...	565
	Vegetable	93	19	644	3200
Same:	Animal	4	49	...	470
	Vegetable	82	23	571	2890
Same:	Animal	29	60	...	680
	Vegetable	72	7	572	2705

The chili is cooked alone, and also with various other articles of food. It is prepared by first removing the stems and seeds of the pods, which constitute somewhat more than half of the total weight, after which it is sometimes ground in the metate, but is usually soaked in water and the inner or edible portion separated from the outer skin by squeezing in the hands. Owing to the extremely strong irritating effect on the hands, this operation cannot be performed by an amateur. The Mexican women, however, become so accustomed to it that it seems to have no effect on them.

Among the poor families the meals are served on the floor in the middle of the room, the family sitting on the ground around the food and eating without knives, forks or plates.

The exceedingly small amount of animal food consumed by some of the negro families studied by Hoffman, and its entire absence, except as represented by lard, in some of the Mexican families as studied by Goss, are shown in the table on the preceding page. This research shows a sufficient source of heat units obtained from vegetable fuel foods, but at the same time it shows an insufficiency of protein, most of which is derived from vegetable foods and in some instances altogether so. For the sake of comparison, consult the Standard Dietary as outlined by Chittenden(17).

USE OF ALCOHOL

A healthy normal individual does not need alcohol. As a beverage it undoubtedly exerts harmful influences upon the human economy. It is absolutely unnecessary in health, but it is so extensively employed in all parts of the world either to produce fictitious exhilaration or, by lessening sensibility, to mitigate fatigue and discomfort, sorrow and suffering, and it has been so largely and so injudiciously used in disease, that it demands some consideration. (*See also* Volume I, Chapter XVI, "Beverages and Stimulants"). Its habitual use prods the heart to greater activity. Richardson, writing on the subject, says: "One ounce of alcohol daily will increase the heart beats 430; 2 ounces, 1,872; 4 ounces, 12,960; 6 ounces, 30,670." But while increasing the rate of the heart, it weakens the force so that the final result is to lower the blood pressure. In other words, while the heart seems to be stimulated, it is really weakened. It is not surprising therefore that a period of enfeeblement of this organ follows the habitual use of alcohol.

The use of alcohol does not increase muscular energy, but on the other hand fatigue is hastened by it. Its effect on individuals varies greatly; some show ill effects on small doses and others are seemingly resistant to large ones. Some people are stimulated by it to eat more heartily and to

put forth less muscular exertion, and since oxidation goes on more slowly in these individuals, they easily accumulate fat, but, although they may appear plump and full fed, they are not, as a rule, resistant to disease nor capable of prolonged, strenuous, muscular exertion. Its habitual use is of no advantage in normal health, while those who are not strong-willed or self-controlled, and those who inherit a love for liquor or have a tendency to inebriety, gout, arteriosclerosis, or other degenerative changes, will be far better without it. It is true, many persons can use it in strict moderation without apparent harm; the majority, however, sooner or later awake to the realization that even with moderation they are not so well when they use it habitually. The continued and habitual use of alcoholic beverages invariably exerts a harmful influence on the human organism. The wisdom or folly of their use in health is not a question that the physiologist alone can determine. The ease with which the habit of imbibing spirituous liquors grows to an excess, and the harmful influences exerted by them on the body politic, make the desirability of their use a social problem as well as a physiological one.

Since alcohol is really a narcotic and not a stimulant at all, and since it is not a food in any real scientific sense, it need not, therefore, be further discussed under the present caption: "Diet in Health."

DIET IN TROPICAL CLIMATES(24)

It has been generally taught that in tropical climates a smaller amount of nitrogenous food is required than in the temperate zones. Of course, it must be premised that the natives of tropical lands are better fitted physically and physiologically to withstand excessive heat and the actinic rays of the sun in hot climates than are the white men who, as a rule, are only sojourners. But even in the case of natives, the long-held ideas that "they should eat the kind of food which is habitual with them because it best suits their requirements," are lapsing into something like disrepute. In fact, within recent years opinions as to diet in the tropics both for natives and for white men have changed very considerably.

General Considerations.—We will present herewith the views of various authorities on the subject, and then endeavor to sift the evidence or leave it to our readers to form their own opinions. The late Dr. Charles Woodruff(25), a man of very decided views and one who was not afraid to express them, however much they might clash with those of other observers, delivered himself somewhat as follows with respect to diet in hot climates. "It used to be an article of faith in physiology, that wherever

we go in the world we should imitate the natives in food, clothing, houses and methods of work. Upon acquaintance with the native we found him poverty stricken, weak, undersized, even half starved, badly housed, filthy, diseased, and of such lack of vitality as to average less than fifteen years of life. To imitate him, as our physiologists taught, was merely to die twenty or twenty-five years before our time." According to Woodruff, false notions are now gradually disappearing in the light of new facts. Take, for example, the matter of meat in the tropics. The orthodox theory was that we must cut down animal foods below the limit found necessary at home, because, forsooth, the native dying of nitrogen starvation could not get as much as he should. The theory was put into practice with disastrous results, and nowadays every army officer knows that to avoid the awful exhaustions caused by tropical climates and the consequent infections, such as tuberculosis, etc., we must have as much animal food as we have at home, or even more.

Perhaps Woodruff was inclined to exaggerate the value of nitrogenous food in the tropics, but there are many who have had experience in the Philippines and in India who hold views very much to his way of thinking. At any rate, the old-time conception that nitrogenous food was contra-indicated in the tropics has been almost exploded.

Lukis and Blackham(26) uphold the teaching that in cold climates the fats should be increased and in warm climates the carbohydrates. Yet they do not insist on a vegetarian diet for white men or natives. They point out in support of the argument, that fats are not suitable for consumption in hot climates, that, while butter is eaten with avidity in the temperate zone, butter or fats of any description are regarded with distaste in the plains of India. These same authorities are not in accord with Chittenden's views, that the current estimations of the amount of protein and total fuel value necessary for hard work are excessive, and they draw attention to the fact that the most recent researches fail to agree with these opinions.

In any climate, the body seeks to maintain a reserve supply of nitrogenous food for its cells. Consequently, a man having a small reserve supply may be considered on a low plane of nutrition, and, *per contra,* one with a large reserve supply may be regarded as on a high plane of nutrition. It also stands to reason that those on a high plane are better able than those on a low plane to resist those infectious diseases which are more or less prevalent in the tropics, as bubonic plague, cholera, tuberculosis, pneumonia, typhoid fever, typhus, relapsing fever and plague. It would seem to follow, in the regular order of things, that white men in the

tropics not well fed on nitrogenous food should readily fall victims to infectious diseases. And this is exactly what happens. They have placed themselves from the dietetic standpoint on a level with the natives, and like them suffer from a lowered vitality, which renders them exceedingly susceptible to infection and liable to succumb to the same, while their wiser or more fortunate meat-eating brothers are easily able to resist.

The argument, then, that, because the natives of the tropics eat little nitrogenous food, white men should follow suit, will not bear close dissection. The natives do not consume nitrogenous food for the very sufficient reason that, as a rule, they are not able to procure it. As referred to previously, a large proportion of the natives are in a state of chronic starvation, and it would be the height of folly, in the opinion of Lukis and Blackham(26), to place white men in a similar position. These writers claim, and doubtless with good reasoning, that the comparative immunity of Englishmen to the infectious diseases that decimate the natives of India is due, in part at least, to their being better fed on nitrogenous food. Major McCay[1] has been engaged during the past few years in experimental research into the question of the effect of a nitrogenous diet, and in his final report shows in a decisive manner that, other things being equal, diet is an all-important factor in determining the degree of physical development and general well-being of a people, and that with a low level of nitrogenous interchange, deficient stamina morally and physically must be expected.

It is obvious that in the performance of manual labor the same expenditure of energy is required in every climate, but, as Tibbles(13) points out, because the climate influences the radiation of heat from the body, and that this radiation is greater in a cold or wet climate and less in a hot than in a temperate climate, more food is needed in a cold than in a hot climate. However, this is considerably modified by circumstances. In civilized countries, and especially in America, the greater loss of heat in a cold climate is prevented by heating the houses and by wearing warm clothes, and the radiation of heat and evaporation from the body in a hot climate is promoted by wearing thin clothing. Although body metabolism is slightly decreased by the greater heat of tropical climates, the production of heat is really not much less than in a temperate climate. Wherefore the conclusion has been reached that it is well not to take less food in hot climates, but to increase slightly the intake of carbohydrates in order to supply the heat radiated from the skin, and with the special object of promoting perspiration. Tibbles, however, doubts whether it is good ad-

[1] Professor of Physiology at Calcutta Medical College.

vice for white men who make their home in the tropics to follow the dietetic habits of the natives and eat a comparatively very small quantity of animal food and large amounts of vegetables and fruits. From long centuries of usage in hot climates, the natives are accustomed to consume such large quantities of rice, pulse and other vegetables as a person unused to such food would be positively unable to take and to digest. The fact must also be taken into account that there should be a fairly definite ratio between the proportion of nitrogen and carbon in the alimentation. The natives of India are not influenced by poverty alone in their choice of food. Not only does necessity impel very large numbers of them to consume materials from the vegetable kingdom, but many are bound by religious scruples to avoid meat. To most of the millions of India the ox is sacred. The hog is *anathema maranatha* to the Hindus and the Mohammedans, as it was to the Egyptians of old and to the Hebrews of the present day(27). Some Hindus are strictly vegetarians, some take no animal food but a little milk and ghee, while others indulge in eggs, fish and game. The Sikhs eat mutton and goat flesh. The Hindus of Punjab eat no meat, but the Mohammedans living in the same region eat meat to a certain extent.

It may be said that evidence seems to show that those natives who eat meat are finer and stronger specimens of humanity than those who desist from flesh consumption. Indeed, the Sikhs, who eat mutton and goat's flesh, are models of good physique and are easily the most vigorous race physically of the inhabitants of India. Nevertheless, it may be pointed out that the variations of climate in India are considerable and, as Sir Havelock Charles aptly says, "it is impossible to formulate exact rules for dietary in the tropics generally because the differences of climate entail modifications." While the same authority says nothing with regard to limiting the consumption of meat, he does say that "no cold meat whatever should come on the table," and that it is important that everything should come straight from the fire to the table, for then it cannot serve as a carrier of disease germs or parasites, and there need be no fear of cholera or dysentery. Boiled water only should be drunk, and no salads of any kind should be used except with the greatest moderation.

Fruits and Vegetables.—As for fruit, that kind which possesses a rind that can be removed may, according to Tibbles, be eaten with impunity by a healthy man at any time of the year. On the other hand, fruits without a rind or peeling are incapable of being thoroughly cleansed and in consequence may be contaminated and dangerous to the consumer unless cooked before eating. Following this rule, oranges, grapefruit, pears,

apples, bananas, mangoes, pineapples, custard apples, mangosteen, tomatoes, etc., may be eaten raw after having been peeled, but grapes, currants, strawberries and those fruits which cannot be peeled are on the taboo list until they have been cooked. Vegetables, such as cabbage, cauliflower, kidney beans, green peas, pumpkins and vegetable marrow, should be eaten fresh boiled.

It can be stated, broadly speaking, that the alimentary principles are the same in the tropics as elsewhere, and, according to Simpson(28), the simple and for the most part vegetable diet of the indigenous inhabitants of the Tropics contains the same nutrient principles as the more complex and varied admixtures of animal and vegetable foodstuffs which form the ordinary diet of races living in colder climates under a modern civilization. In Europe, meat chiefly supplies the protein in the food; bread, potatoes, etc., the carbohydrates; and butter the fat; while in tropical lands, the protein in the food is supplied mainly by fish, peas, beans and other legumes; the carbohydrates by millet, cereals, manioc, yams, etc., and the fat by vegetable oils such as ground nut and olive oil. Butter ghee, of animal origin, is clarified butter made from the oil from the liver of fish and the fat of beef and mutton. It is a good butter, but its peculiar flavor renders it distasteful to a European palate. The vegetable oils are expressed from various seeds and are used either for cooking purposes or in place of butter.

Vegetable foods are represented by cereals, pulses, tubers, herbaceous vegetables and fruits. Of roots and tubers, the chief are the sweet potato, the yam, the tars and the cassava or manioc. According to Simpson, there is in the roots less than 1 per cent of protein and of fat, and their food value consists in the potash salts and the amount of starch which they contain, the latter constituent varying from 15 to nearly 30 per cent; tapioca contains about 86 per cent of starch. Rice, ragi, millet, maize, and other cereals form, as a rule, the staple foods of the tropics. They contain too small proportions of protein and oil to furnish sufficient protein by themselves, and consequently their deficiencies are made up by an admixture of a small quantity of legumes. The pulses or peas and beans are particularly rich in nitrogenous, starchy and phosphorated principles. They contain, at least, 20 per cent of proteins. But, after all, for the great mass of the people of India—in fact, for the vast majority of the inhabitants of tropical Asia—rice is the staple food. There are two principal varieties, Burma and country rice. Burma rice, being highly milled, has the husk, pericarp and outer layer removed by machinery, stripping it of its protein, phosphorus and vitamines. Country rice is soaked in water

TABLE I.—PROTEIN AND STARCH EQUIVALENTS IN CEREALS AND BUCKWHEATS (Church)[1]

(The figures represent ounces and decimals of an ounce)

	1 oz.	2 oz.	3 oz.	4 oz.	5 oz.	6 oz.	7 oz.	8 oz.	9 oz.
Ragi:									
Protein.........	.059	.118	.177	.236	.295	.354	.413	.472	.531
Starch..........	.764	1.528	2.292	3.056	3.820	4.584	4.348	6.112	6.876
Koda:									
Protein.........	.07	.14	.21	.28	.35	.42	.49	.56	.63
Starch..........	.82	1.64	2.46	3.28	4.10	4.92	5.74	6.56	7.38
Rice:									
Protein.........	.073	.146	.219	.292	.365	.438	.511	.584	.657
Starch..........	.797	1.594	2.391	3.188	3.985	4.782	5.579	6.376	7.173
Sanwa:									
Protein.........	.084	.168	.252	.336	.420	.504	.588	.672	.756
Starch..........	.794	1.588	2.382	3.176	3.970	4.764	5.558	6.352	7.146
Gundi:									
Protein.........	.091	.182	.273	.364	.455	.546	.637	.728	.819
Starch..........	.773	1.546	2.319	3.092	3.865	4.638	5.411	6.184	6.957
Maize:									
Protein.........	.095	.190	.285	.380	.475	.570	.665	.760	.885
Starch..........	.790	1.580	2.370	3.160	3.950	4.740	5.430	6.320	7.110
Joar:									
Protein.........	.093	.186	.279	.372	.465	.558	.651	.744	.837
Starch..........	.769	1.538	2.307	3.076	3.845	4.614	5.383	6.152	6.921
Shama:									
Protein.........	.096	.192	.288	.384	.480	.576	.672	.768	.864
Starch..........	.757	1.514	2.271	3.028	3.785	4.542	5.299	6.056	6.813
Bajra:									
Protein.........	.104	.208	.312	.416	.520	.624	.728	.832	.936
Starch..........	.791	1.582	2.373	3.164	3.955	4.746	5.537	6.328	7.119
Kangni:									
Protein.........	.108	.216	.324	.432	.540	.648	.756	.864	.972
Starch..........	.801	1.602	2.403	3.204	4.005	4.806	5.607	6.408	7.209
Barley:									
Protein.........	.115	.230	.345	.460	.575	.690	.805	.920	1.035
Starch..........	.730	1.460	2.190	2.920	3.650	4.380	5.110	5.840	6.570
Chena:									
Protein.........	.126	.252	.378	.504	.630	.756	.882	1.008	1.134
Starch..........	.777	1.554	2.221	3.108	3.885	4.662	5.439	6.216	6.993
Amaranth:									
Protein.........	.143	.286	.429	.572	.715	.858	1.001	1.144	1.287
Starch..........	.760	1.520	2.280	3.040	3.800	4.560	5.320	6.080	6.840
Wheat:									
Protein.........	.135	.270	.405	.540	.675	.810	.945	1.080	1.215
Starch..........	.712	1.424	2.136	2.848	3.560	4.272	4.984	5.696	6.408
Buckwheat:									
Protein.........	.152	.304	.456	.608	.760	.912	1.064	1.216	1.368
Starch..........	.714	1.428	2.142	2.856	3.570	4.284	4.998	5.712	6.426
Quinoa:									
Protein.........	.192	.384	.576	.768	.960	1.152	1.344	1.536	1.728
Starch..........	.578	1.156	1.734	2.312	2.890	3.468	4.046	4.624	5.202

[1] Simpson in "Tropical Hygiene."

TABLE II.—PROTEIN AND STARCH EQUIVALENTS IN PULSE (Church)[1]

(The figures represent ounces and decimals of an ounce)

	1 oz.	2 oz.	3 oz.	4 oz.	5 oz.	6 oz.	7 oz.
Soy Beans:							
Protein	.353	.706	1.059	1.412	1.765	2.118	2.471
Starch	.694	1.388	2.082	2.776	3.470	4.164	4.858
Vetchlings:							
Protein	.319	.638	.957	1.276	1.595	1.914	2.233
Starch	.521	1.042	1.563	2.084	2.605	3.126	3.647
Lupines:							
Protein	.317	.634	.951	1.268	1.585	1.902	2.219
Starch	.452	.904	1.356	1.808	2.260	2.712	3.164
Vetches:							
Protein	.315	.630	.945	1.260	1.575	1.890	2.205
Starch	.497	.994	1.491	1.988	2.485	2.982	3.479
Guar:							
Protein	.298	.596	.894	1.192	1.490	1.788	2.086
Starch	.494	.988	1.482	1.976	2.470	2.964	3.458
Lentils:							
Protein	.249	.498	.747	.996	1.245	1,494	1.743
Starch	.595	1.190	1.785	2.380	2.975	3.570	4.165
Peanuts:							
Protein	.245	.490	.735	.980	1.225	1.470	1.715
Starch	1.267	2.534	3.801	5.068	6.335	7.602	8.869
Moth:							
Protein	.238	.476	.714	.952	1.190	1.428	1.666
Starch	.580	1.160	1.740	2.320	2.900	3.480	4.060
Peas:							
Protein	.236	.472	.708	.944	1.180	1.416	1.652
Starch	.575	1.150	1.725	2.300	2.875	3.450	4.025
Catiang-beans:							
Protein	.231	.462	.693	.924	1.155	1.386	1.617
Starch	.578	1.156	1.734	2.312	2.890	3.468	4.046
Haricots:							
Protein	.230	.460	.690	.920	1.150	1.380	1.610
Starch	.576	1.152	1.728	2.304	2.880	3.456	4.032
Mung-beans:							
Protein	.227	.454	.681	.908	1.135	1.362	1.587
Starch	.608	1.216	1.824	2.432	3.040	3.648	4.276
Horsegram:							
Protein	.225	.450	.675	.900	1.125	1.350	1.575
Starch	.603	1.206	1.809	2.412	3.015	3.618	4.221
Lablab-beans:							
Protein	.224	.448	.672	.896	1.120	1.344	1.568
Starch	.574	1.148	1.722	2.296	2.870	3.444	4.018
Pigeon-peas:							
Protein	.203	.406	.609	.812	1.015	1.218	1.421
Starch	.596	1.192	1.788	2.384	2.980	3.376	4.172
Chick-peas:							
Protein	.195	.390	.585	.780	.975	1.170	1.365
Starch	.643	1.286	1.929	2.572	3.215	3.858	4.501
Inga-beans:							
Protein	.176	.352	.528	.704	.880	1.056	1.232
Starch	.807	1.614	2.421	3.228	4.035	4.842	5.649

[1] Simpson in "Tropical Hygiene."

for at least a day and night, and then strained and dried in the sun, after which the husk is roughly removed. It therefore retains most of its pericarp and outer layers, which contain protein, phosphates and vitamines. Rice is the poorest of the cereals in protein and mineral matter. On the other hand, it has the advantage of occurring in small and easily digested grains. Boiled rice swells and absorbs nearly five times its weight of water, while some of its mineral constituents are lost by solution. Rice, being largely starch, is only in very small part digested in the stomach, but Lukis and Blackham state that its solid constituents, being quite completely digested in the small intestine, enter the blood almost as completely as those of meat—two and one-half ounces cooked by boiling requiring three and a half hours for disposal. Practically none of the starch is lost, whereas the waste of protein foods amounts to about 19 per cent. It follows from this that rice is one of the foods which leaves the smallest residue in the intestine, a property which gives it a considerable value in some cases of disease.

As Simpson points out, in the construction of European standard diets the basis has generally been a person weighing 154 pounds and doing a day's work of 300 foot-tons, or about 2 foot-tons per pound of body-weight. In Indian and Japanese dietary tables the lesser body-weight of 105 pounds has usually formed the basis, the 2 foot-tons of work being retained.

Church gives the following standard diets for Indians weighing 105 pounds, expressed in avoirdupois ounces and decimals of an ounce:

CHURCH'S STANDARD DIET FOR INDIANS

Ration	Protein	Oil	Starch	Starch equivalent	Nutrient ratio
Bare sustenance	2.1	0.752	7.520	9.250	1:4.34
Moderate work	2.954	1.412	12.531	15.779	1:5.34
Hard work	3.635	2.506	11.190	16.954	1:4.66

Lukis and Blackham give the following as the scale in a Bengal jail:

Burma or country rice	20 ounces
Different dals	6 "
Vegetables	6 "
Flour, Wheat or Indian Corn	10 or 12 ounces

These amounts represent only what is absolutely essential. Perhaps a better standard is furnished by the war ration of the Indian sepoy,

which generally consists of atta or rice, 2 pounds, or sometimes meat or fish, 2 pounds; ghee, 2 ounces; dal, 4 ounces; salt, 3/4 ounce; also meat and condiments on payment. In some expeditions onions and dried mangoes have been issued. The following ration has been suggested for Aden camel drivers: Biscuit or rice, 1 1/2 pounds; dates, wet, 1 pound; ghee, 2 ounces; sugar, 2 ounces; coffee, 1/3 ounce; salt, 1/2 ounce; onions, 2 ounces, or dal, 3/4 ounce.

Church, quoted by Simpson, gives several examples of rations, viz.: A dietary for moderate work, according to this author, calls for 2.954 oz. protein, 1.412 oz. oil, and 12.531 oz. starch, the starch equivalent of which is 15.779. Soy beans, 5 oz., furnish protein 1.765, starch 3.470. Rice, 16 oz., furnishes protein 1.163, starch 12.752. Total protein 2.928. Total starch 16.222. As the oil, however, in this ration is but 1 oz. and should be 1.4 oz., it will be necessary to add the lacking four-tenths. To do this without disturbing the ration, 1 1/2 oz. of rice should be withdrawn, and 1/2 oz. of soy beans added. Then the amounts will be, soy beans, 5 1/2 oz., furnish protein, 1.942, starch 3.817. Rice, 14 1/2 oz., furnishes protein .954, starch 11.552, oil .4 oz., the oil being equal to starch .920. This ration has, therefore, 2.896 oz. protein and the equivalent of 16.289 starch.

Church lays down two guiding principles, one is to keep down the legume constituent to an amount not exceeding 7 ounces per diem, and if possible not more than 5 ounces per diem; the other is to ensure the presence of a sufficiency of protein (or albuminoids, as he calls them) by increasing the cereal constituents of the ration, even if in so doing the quantity of starch required be raised above the necessary amount.

Milk.—Manson(29), referring to the milk supply in tropical countries, says, in part, "that in many tropical countries, such as West Africa, milk cannot be obtained except in preserved form. In other countries, as India, cow's, goat's or buffalo's milk can be readily procured. Buffalo's milk is very rich in fat, there being nearly twice as much as in cow's milk. It is also richer in proteins, though not so rich in lactose. It is less digestible, has a peculiar smell and flavor, and, as a rule, is not suited for invalids. Goat's milk differs less from cow's milk; but as the goat is susceptible to Malta fever, and the *Micrococcus melitensis* is discharged in the milk of infected animals, it is better not to use the milk unless efficiently pasteurized or well boiled." The Board of Agriculture and Fisheries of Great Britain published, in the early part of February, 1916, a circular relating to goat's milk, in which it was stated that it is, as a rule, a most wholesome milk, and that its flavor, if the food of the animal

is regulated, is not any real drawback to its employment. Moreover, goat's milk is easily digested by children, and is far less likely than cow's milk to contain tubercle bacilli. The composition of cow's milk and goat's milk is much the same, although goat's milk is superior as regards fat, which is an advantage.

Where cow's milk is available it should be used in preference to preserved milk. In the tropics, as stated previously, unless milk can be consumed fresh from the cow, it must be boiled, or efficiently pasteurized, and thus rendered slightly less digestible and deprived of certain of its nutritive properties. Manson states that it is necessary to boil milk in the tropics, "because (*a*) under tropical conditions, the multiplication of bacteria is so rapid that milk quickly turns sour; (*b*) the natives frequently add water to the milk and are apt to be careless as regards the washing and scalding of the utensils used; (*c*) the water used for such dilution and for washing utensils is usually drawn from shallow pools or wells liable to contamination, especially as inspection and regulation of the milk supplies in the tropics are very lax; (*d*) obvious impurities are strained off with old rags or articles of clothing actually in use; (*e*) cattle are often fed on garbage of all kinds."

The alternative to boiling milk, when it is intended for consumption by Europeans, or for use in hospitals, is to keep the cows under the best sanitary conditions possible and to be sure that they are milked under strict sanitary precautions. It is patent that the difficulties in the way of insuring a comparatively pure milk are so great in tropical countries as to be nearly insuperable. Moreover, in many districts fresh milk is not available. It therefore follows that canned milk is largely used. Manson is of the opinion that the sweetened milks should be avoided for the use of invalids, and thinks that the best tinned milks are those in which the milk is not reduced to a paste but merely concentrated and is still in fluid form. The can must be carefully examined to see that there has been no previous puncture or bulging, and the milk must be odorless. A can once opened must be used quickly.

Meats.—Simpson, unlike Lukis and Blackham, is inclined to agree with the views of Chittenden that most people eat more protein food than is requisite to preserve health and maintain energy. But it must be taken into consideration that, since Simpson wrote his work on diet in the tropics, the investigations of other workers appear to have demonstrated with greater or less certainty that Chittenden's views are not altogether borne out by facts, and are in some degree misleading. Simpson draws from a study of Chittenden's experiments the conclusion that not only

does the European standard of diet err in the direction of allowing too great an amount of proteins, but argues that greater efficiency in working power, and a better feeling of well being and health are attained by a smaller amount of proteins than with the excessive amounts taken in ordinary diets, which, as a rule, contain even more than outlined in the standard diets. He thinks that the evidence put forward in favor of these views is strong, and is supported by the fact that nations such as the Japanese or Indians, living a simpler life, and more given to vegetarianism than the Europeans or Americans, are maintained in health on a much smaller amount of protein food than these standards indicate is necessary. According to Simpson, although man requires a mixed diet, with some reservations relating to custom and climate, it is a matter of indifference whether the mixed diet is obtained wholly from vegetable products, or partly from animal and partly from vegetable products, and it is further his opinion that whether grains or meat shall enter most largely into the diet depends a great deal on climate, on the habits of the people, whether indolent or active, and on other circumstances.

However, although this authority seems to favor a vegetarian diet for natives and a diet for white men in the tropics in which the carbohydrates preponderate, the force of his argument is somewhat lessened, so far as the natives are concerned, by the following statement made by him. The inhabitants of hot climates are generally content with milk products, legumes, fruits and sugars, but though cereal grains, as a rule, form the chief food of such people, rice being the staple wherever there is plenty of water and rain, still there are considerable numbers whose food is largely from the animal kingdom. Thus, the Arabs of East Africa, the Pampas Indians, and the Abyssinians are often quoted as instances of consumers of large quantities of meat. They are all very active races. Indeed, as pointed out before, the mass of the inhabitants of India who exist mainly on rice and some other cereals are, generally speaking, miserable specimens of humanity, exceedingly prone to infection, and so deficient in vitality that when attacked by disease they die like flies. The vigorous races of India are those who eat flesh, not to excess, but still sufficient in amount to supply the protein needs of the organism. It is also worthy of notice that the Japanese, who of all the Asiatic peoples are especially capable, physically and mentally, do not, by any means, restrict themselves to a vegetarian diet. It is true, though, that at one time the Japanese might have been termed a vegetarian people, but this was more from necessity than choice, and they have always been great fish eaters. During the Russo-Japanese war, when the Japanese soldiers were justly

lauded for their remarkable powers of endurance, their capabilities in this direction were attributed to their being vegetarians. When, however, the matter was more closely investigated, it was found that the Japanese soldiers' rations comprised a certain amount of meat.

A point, too, to which attention is not sufficiently paid, is that while diet must be modified to some extent to adapt it to the physiological requirements of varying climates, to insist that a white man in the tropics must eat the same food as the native is carrying this principle to absurd lengths. Evidence, and recent evidence in particular, would seem to go to show that even the native who has been so long accustomed to a carbohydrate diet that it has become a fixed habit, is all the better for some meat. Simpson takes the stand that the most probable defect in the diet of a European in the tropics is that it is too nitrogenous and fatty, and illustrates this contention by an instance drawn from history or tradition. When the Aryans first descended into the plains of India they were meat eaters, but the experience of the centuries evidently taught them to be vegetarians, or to be very sparing in the amount of meat they ate, and at the same time to become total abstainers. This, says Simpson, is an experience and a lesson which Europeans who go to the tropics are inclined to ignore. Accustomed to living well in their own country, on large quantities of meat, fats and rich foods, to which wines and spirits are added in considerable quantities, they are tempted to follow, as closely as possible, a similar diet in the tropics. This procedure is generally followed by injurious results due to want of adjustment of the diet to the new conditions, and is often disastrous to the health, as attested by the history of the British occupation of India. Within recent years an adjustment has taken place, and the health and mortality of Europeans have undergone a great change for the better. Emphasis may again be laid on the point that the present inhabitants of India eat mainly carbohydrate food simply from economical reasons or because their religion forbids them to consume meat, and, as stated before, those of the natives who eat meat in India are greatly superior in physique and in powers of endurance to the vegetarians.

With regard to the too indulgent habits of the white men who come to the tropics, it is no doubt true that they eat and drink more than is good for them, though this was more frequently the case in former times than at the present. But as Sir Patrick Manson(29), who is probably the greatest living authority on such matters, says, the effects of dietetic errors in Europeans in the tropics are, on the whole, more marked than would be the case from similar errors in temperate climates. This is

especially so as regards the abuse of alcohol and condiments, and also as regards the deficiency of fresh vegetables, of fruits and occasionally of meat. Manson has at once placed his finger on the dietetic error of the European in the tropics which most tends to injure his digestive organs, upset his nervous system, impair his health generally, and sap his vital forces. This is the too great consumption of alcohol and condiments. It must be borne in mind that the meat one gets in the tropics is not like the meat of temperate climes. The animals there are not well fed, and their meat is usually stringy, tough and of an insipid flavor. The consequence is that more thorough cooking is resorted to. This in itself destroys or lessens the already somewhat meager nutritive properties of the meat, and, in addition, to give some zest to the food the dishes are frequently highly spiced and a larger variety of methods of preparation are employed. The result is that, while the bulk of the food taken is as much or even more than in Europe, the good effects of the protein material are greatly decreased by its being taken in indigestible forms. In fact, food so cooked and spiced often does more harm than good. Again, the fruits are sometimes comparatively dry and tasteless, as is apt to be the case in all tropical climates where they mature quickly, and the vegetables are liable to be indigestible and of inferior quality.

It must, then, be taken into consideration that in the tropics neither meat nor foods from the vegetable kingdom are of the same high standard as in temperate climes. When injudicious cooking and the too liberal use of condiments are added to these drawbacks, it may be well understood why digestive disorders prevail. Nevertheless, with all dietetic and culinary obstacles with which the white man has to contend, the fact stands out clearly that he possesses a resisting power to infection and disease which is absent from the native. Moreover, it may be once again insisted upon that the meat-eating native has a superior vitality to the vegetarian inhabitant of tropical Asia, which goes to show that the majority of the indigenous population of the tropics do not eat enough protein material.

Sweets.—A very interesting and instructive feature in connection with diet in the tropics is that Europeans born and bred in tropical lands have less desire for meat and a special predeliction, sometimes amounting to a craving, for sugar. Inhabitants of the Far East and the dwellers in hot climates generally exhibit an excessive desire for sweet things. When presents are made in Asia, they usually take the form of sweetmeats, and the ladies of the harem are depicted, as a rule, lolling on couches and forever eating sweets. No doubt this craving has a physiological basis.

Sweets take the place to some extent of protein material, or rather are protein sparers, being rapidly oxidized. In the Boer war the British soldiers were supplied with a daily ration of chocolate, for it is known to liberate energy rapidly with the least possible strain upon the digestive system. Sugar, an almost pure soluble carbohydrate, is perhaps the best food for this purpose. Mosso first demonstrated that sugar lessened fatigue, while Vaughan Harley showed that it was an excellent spur to energy with which extraordinary muscular exertion could be made.

Simpson mentions that among the troops engaged in Porto Rico and in the Philippines whose appetites had become impaired, there was a craving for candy and sweets which was relieved by a supply of these articles. Numerous experiments have demonstrated that fatigue is more quickly relieved by sugar than by any other kind of food, and in the tropics, where exhaustion, by reason of the heat and the actinic rays of the sun, is most likely to occur, the value of sugar can scarcely be overestimated.

Diet and Disease.—When writing or speaking of diet in the tropics one must be careful to avoid the faults of exaggeration. To assert that a white man should eat as much meat or more than in a temperate climate would be, perhaps, to sin in this direction. On the other hand, to aver that a strictly carbohydrate diet was the one most suitable for the white dweller in a hot climate would be to err even more grossly. Although white men have dwelt in the tropics for generations, scientific men still agree to differ as to the form of diet best adapted to the climate. Recent investigations appear to prove that a mixed or modified diet is not only the best for white men but for the natives themselves. It is absolutely certain that rice, and especially milled rice, the form of food most largely eaten by the natives, is deficient in nitrogenous matter and over bulky in carbonaceous matter. The best rice is also deficient in phosphoric acid, lime and other mineral matters. As a matter of fact, the diet of the natives is responsible for lowered vitality and is directly responsible, according to many authorities, for beriberi.

Accordingly, diet may be a direct cause of disease. Excess of protein material in the diet of the European, and deficiency of proteins in that of the poorer classes of natives, and in some institutions, are instances of this.

In the prevention of disease, it goes without saying that diet plays a rôle of the utmost importance. Putting on one side the chronic diseases which are likely to occur in the tropics from errors of diet more quickly than in colder lands, it must be remembered that food contamination is

rife in hot climates. Flies in such countries are indeed a veritable plague, and if extreme care be not taken to protect food, epidemics will be spread far and wide. Human excreta are less thoroughly dealt with and provide a remarkably favorable means by which flies may convey disease. Cholera, as well as typhoid fever, has been shown to be carried in this manner, and flies are under suspicion of being concerned in the dissemination of other diseases.

Canned Foods.—Before leaving the subject of diet in the tropics, it may not be out of place to consider briefly the question of canned foods. In the torrid lands, for obvious reasons, canned foods are largely consumed. Of course, they are more frequently used than they should be, for their nutritive value is less than that of fresh meat and their consumption is open to several other objections. There is a certain amount of risk of metallic poisoning, but the gravest charge that can be brought against the indiscriminate use of canned meat is that it is always difficult to determine how long the food has been tinned. The temptation to send abroad tins already old is too great for some unscrupulous dealers. In any event, tins of meat which have been kept for a considerable period are retailed in all parts of the tropics with the result that serious digestive disorders are frequent, and even ptomaine poisoning is by no means rare.

Conclusions.—In the light of the most recent researches, it would seem to have been demonstrated that a goodly amount of protein material should be eaten by the white dwellers in the tropics, and that it is not in the interests of health that the protein part of the diet should be unduly decreased. It would be manifestly unwise for the white man to endeavor to subsist on the form of food eaten by the native. A modified diet is best suited to the bodily and mental requirements of the white man in the tropics, but as in temperate climates he must be largely guided by his mode of life. Such a diet should not contain so much protein matter as in colder climates, but the carbohydrates and proteins should be judiciously distributed in proportion to the individual's needs. In the case of white men, at any rate, most of the protein material should be supplied by meat. Meat should not be cooked too long nor should condiments be added to any great extent. Great care should be exercised in protecting foodstuffs, and especially meat and milk, from contamination or infection, and milk and meat should be consumed as fresh as is possible. Moderation in eating should be the slogan of the white man in the tropics, and if the above rules are carefully observed, there is no reason, at least so far as diet is concerned, why he should not enjoy good health. It must be remembered, however, that he must accommodate his diet, to a certain extent, to the

variations of climate, which are more frequent in tropical than in temperate zones.

Into the question of the diet of the natives, it is superfluous to enter at length. Suffice it to reiterate that investigations seem to show that those who eat meat are more vigorous than those who are vegetarians. It will be observed that in this section the diet of India has been mainly discussed. This is because more is accurately known of the diet question in India than in other tropical parts of the world. Still it is known that, in Africa and in other tropical climates, those natives who eat meat are stronger than those who subsist solely on vegetable foods. The subject has been treated in a broad way and only general principles have been laid down, and while the authors are conscious that the matter has been dealt with somewhat discursively, it is hoped that the information given may prove of some practical value.

ALCOHOL AND BEVERAGES IN THE TROPICS

The question of alcohol as a beverage or as a medicine is a vexed one among scientific and medical men, and has been the cause of a good deal of acrimonious discussion. There are those who, like Sir Victor Horsley, hold that it is a poison in any circumstance, and contend that its value as a medicinal remedy is *nil.* Again there are those like Karl Pearson, Atwater and others, who deny that alcohol is absolutely useless, and argue that it has a food value and that, when taken in discretion, it by no means always does harm, and may, on occasions, do good. Pearson appears to have proved that the sins of the fathers are not visited on the children, that is, so far as the hereditary influence of alcohol is concerned. He made a series of careful investigations and seems to have demonstrated that the children of habitual drinkers differ but little, if at all, from those of the abstainer or from the ordinary moderate drinking individual. However, this assertion and the investigations upon which it was based were severely criticised by Horsley and his followers, and it does appear probable that the offspring of drunkards exhibit certain inherited physical and mental characteristics of an abnormal nature. They have handed down to them, as a rule, a somewhat unstable nervous system, which renders them more prone to the effects of stimulating drinks than their fellows who have not had as their progenitors those addicted to the excessive use of alcohol. However, alcohol and its effects have been exhaustively discussed from the scientific standpoint in the chapter on "Stimulants," and, as recapitulation is a weariness of the flesh, we will refrain from offending our readers in this respect.

The subject of the use of alcohol in the tropics will be gone over briefly, and its *pros* and *cons* considered impartially. For some time now, it has been taught by the majority of medical men who have had such a varied and lengthy experience of life in the tropics as to warrant them to speak with authority, that alcohol wreaks more injury on the human organism than in temperate climes. This may be so, but the evidence forthcoming does not appear to be entirely convincing. It is assuredly true that in bygone days both meat eating and heavy drinking were the custom in the tropics, as elsewhere, and that the consequences were in a high degree injurious. Even now it is said that in some tropical lands, East Africa, for instance, the white men eat unsuitable food, drink to excess, and suffer accordingly. In India this is the exception rather than the rule. There the white man is generally absteminous with correspondingly good results. Exactly the same thing, however, has occurred in Europe, and especially in Great Britain. It is not so very many years ago, in fact, almost within the memory of the older members of the community, that gross feeding and heavy drinking were habitual with a large proportion of the prosperous and well-to-do in the United Kingdom. In recent years such habits have fallen into disrepute, and, although spirit and beer drinking have prevailed in the British Isles, members of the prosperous and well-to-do class, from which the white civil officials of India and the officers of the Army are drawn, no longer gorge themselves with food and drink. As said before, both in India and Europe the results of this moderation have been exhibited in superior efficiency of mind and body.

However, the point is as to whether alcohol is more harmful in tropical climates than in temperate countries. Manson says that the abuse of alcohol and condiments is a fruitful cause of digestive derangements and of various diseases in tropical climates, but so is the abuse of alcohol and of indigestible foods in colder lands. The majority of authorities are of the opinion that alcohol is more injurious in the tropics or, at any rate, they strongly urge against the use of alcohol and usually advise white men sojourning there to be abstainers.

The late Dr. Charles Woodruff, who, as mentioned previously, combated the crystallized view that the meat part of the white men's dietary should be decreased in the tropics, also stoutly defended the use of alcohol in strict moderation in both the tropics and in other portions of the globe. Among the numerous statistics he brings forward and the many authorities he cites, is a statement made by Dr. Leon Meunier of Paris, published in the *Cosmos,* July 14th, 1903, that with regard to small amounts of

alcohol the experience of centuries was to the effect that such an amount is not only harmless, but is a beneficial food, which can take the place of an equal energy in butter and similar fuels, irrespective of the state of rest, work or any circumstance relating to the consumer. Woodruff goes on to say that the great majority of the medical profession have reached the decision that alcohol is like every other chemical, whether it be a poison like strychnin or a food like protein; that is to say, there is an amount below which it is not a poison and above which it is poisonous. Woodruff's array of figures and authorities seems to bear out his own view, that in the terribly depressing, anemic conditions brought about by living in a tropical climate, against whose onslaughts he has no protection like the dark-skinned native, a white man who is not assisted by a little alcohol is more harmed by the climate than the man who is so aided.

Simpson does not commit himself to the expression of any very decided opinion on the subject, but gives this guarded statement, that it is safest for the newcomer to abstain from alcoholic beverages, especially so if much exposure to the sun is to be endured. Tea and coffee are the customary drinks of many of the inhabitants of the tropics, and where these are not in use, water is generally the only beverage. He thinks it is well to follow the custom of the country in this respect. When alcoholic drinks are used—and they are often found necessary to the European after he has been some years in the tropics—they should only be taken at meals, preferably with the dinner in the evening, and then in extreme moderation.

Lukis and Blackham are of the opinion that "a certain amount of alcohol may be safely consumed as a heat-producing food." This amount is certainly very limited, not more than one or, at the outside, two ounces in twenty-four hours. Its unsuitability as a food is shown by its other effects on the body which are so well known as to need no description, and which, in fact, have been fully described in the section of this book dealing with stimulants. It is allowable in some cases when, for some reason, insufficient food is taken. When sufficient food is taken, alcohol is unnecessary, and when excess of food is taken the addition of alcohol may do serious harm. It may also be said—and this point has been elaborated in the section on alcohol—that this stimulant is exceedingly valuable in cases of exhaustion arising from sickness or fatigue, because of its anesthetic effect. This property of alcohol would seem to have been proved times without number. When very hard work has been done under adverse climatic conditions, and when extreme fatigue supervenes as a result of the excessive expenditure of muscular energy, and the vital forces are

brought to a very low ebb, alcohol acts as an anesthetic and one forgets his depression.

However, the present tendency perhaps of scientific and military authorities is to frown upon the habitual use of alcohol in the tropics and to deprecate even its use as a spur in cases of exhaustion. Kitchener, it is said, would not permit soldiers under his command in the Soudan campaign to take alcohol, and substituted tea, coffee or cocoa. Sir R. Havelock Charles, a soldier of wide tropical experience, recorded his opinion in *The Practitioner,* 1910, that alcohol is absolutely unnecessary, and if taken at all should be as a luxury. Tibbles says that it is admitted by all authorities that the use of alcohol in the tropics is a matter requiring grave consideration, and that men are better in health and can perform their duties more satisfactorily without it. Cantlie wrote that the natives of warm climates, both by their religion and their habits, shun alcohol. This statement must be taken with a certain amount of reservation. The Mohammedan religion is against the use of alcohol, but in India and elsewhere many Mohammedans drink when they can afford to do so, and possibly the chief deterrent to the use of alcohol is the extreme poverty of the mass of the tropical population.

All those who have studied the question either from the practical or scientific standpoint are agreed on the point that if alcohol be taken at all in the tropics, it should be drunk in moderation and even sparingly. Lukis and Blackham say that in hot, moist (that is, tropical) climates, beer can rarely be taken with impunity, but that no harm is done by light wines (white or red), champagne and good whiskey well diluted and taken either with meals or after excessive fatigue in small quantities. On the contrary, it is evident that a weak "peg" or glass of wine with the evening meal is beneficial to the harassed Indian official at the end of a strenuous day's work. It promotes digestion and has a soothing effect on the nerves. What does most harm in India and in other parts of Asia where white men congregate is the practice of "pegging," or of taking "short drinks" at the club bar before dinner. It is obvious that spirits, if as harmful as many scientists say, are less harmful when freely diluted. Therefore, when drunk customarily, and not wholly employed as a spur in cases of exhaustion, they should be well diluted and taken in strict moderation. Tibbles says "that about half a pint of red wine or one pint of beer daily is considered a fair allowance, but he is of the opinion that even such a modicum is better replaced by tea, coffee, cocoa or their substitutes, caffer tea, dorn-the, gooranut, kola, kat, mote, guarana, and other native beverages." Natives in all tropical climates, when not debarred by

poverty or restrained by religious scruples, drink spirituous beverages of domestic manufacture. These are made from any article of food which will ferment. Whether made in South America, in Asia, or in Africa, they are, generally speaking, deadly to the natives and more deadly to the white men who are foolish enough to partake of them. This has been proven by the disastrous experience of American soldiers in the Philippines.

Native drinks are many and various. Doasta distilled from rice liquor is sold in Calcutta. Mann states that it is 20 degrees under proof, but contains 0.56 per cent of higher alcohols or 491 grains per gallon. Sugar refuse yields a liquor known as Shajehanjur rum, which is sold 53 to 56 degrees under proof. In Bengal and Assam, the flowers of *Bassia latifolia* contribute a spirit named Mahua. It is sold 22 to 50 degrees under proof, and contains 0.004 to 0.33 per cent of higher alcohols and is a very poisonous and deleterious concoction even to the natives. The notorious arrack is distilled from the sap of the palm tree in India and Ceylon, but the characteristic which has given it its evil name is the fact that it is frequently drugged. Other vile beverages are fairly common among the inhabitants of Asia and other tropical countries. Some of these native drinks are less harmful than the European spirits, but some of them are most pernicious.

It is difficult, indeed impossible, to write dogmatically with regard to the effects of the imbibing of alcohol in the tropics, or to state definitely that it is more injurious to the human being there than in temperate climates. Drinking to excess is harmful everywhere, and its baneful effects are too plainly evident in every civilized land. Two reasons, and these not scientific ones, why white men should be abstemious as regards alcohol, in the tropics, are that by so doing they set a good example to the natives and that if they drink more than is good for them they are apt to deteriorate more quickly in the tropics than in a colder climate.

While the last word has not been said on the question of alcohol as a beverage, it must be confessed that the weight of scientific evidence is on the side of those who contend that the use of alcohol is almost always contra-indicated. Some, like Horsley, say always. Nevertheless, there is a large number of men, few of whom perhaps are of so high a scientific caliber as the opponents of alcohol, but who have had more practical experience, who hold that alcohol has its value and that its use as a beverage should not be entirely barred. Problems of this kind cannot be wholly solved in the laboratory. The argument that, because an undue proportion of a population undergoes deterioration, mental and physical, through

drink, it should be abolished, may be good and sound from the scientific point of view, but it may not be an altogether practical position to take.

There is one feature in connection with the consumption of alcoholic beverages in the tropics of which little notice seems to have been taken. This is, that, owing to the heat, elimination and excretion are more profuse and rapid by far than in cold climates. Consequently it is reasonable to suppose that alcohol will pass out of the system more quickly and do less harm than in more frigid lands. It is acknowledged that the most injurious effects of alcohol are on the nervous system, rendered possible by prolonged poisoning.

Dr. Winfield Scott Hall points out(30) that the theory that alcohol is a food is disproved by recent researches. All life activity is accompanied by oxidation, and all oxidation by waste. Any sparing action which alcohol may possess is easily accounted for as being in harmony with its generally accepted narcotic action. Narcotic action is followed by decreased activity, therefore decreased oxidation, therefore "sparing." Nobody has contended, much less proven, that this so-called sparing action is an economy of food material in connection with activity. With the influence of alcohol as without it, a given amount of life activity is accompanied by a given consumption of body substance, and it is inane and foolish to contend that the sparing action of alcohol, due to its narcotic effect, should be accepted as an argument proving its food value.

The oxidation of alcohol liberates heat energy, but this energy cannot be utilized by the body, even for the maintenance of body temperature. If a food is defined as a substance which, taken into the body, is assimilated and used either to build up or repair body structure, or to be oxidized in the tissues to liberate the energies used by the tissues in their normal activity, then alcohol is not a food. If alcohol is not a real food, what is the significance of its oxidation? It has long been known that the liver produces oxidases, and that it is the site of active oxidation of mid-products of catabolism, of toxins, and of other toxic substances. Alcohol, while usually formed as an excretion of the yeast plant, is also found as a mid-product of tissue. It belongs clearly, then, to the group of excreta. Experiments conducted by Dr. Reid Hunt and other experiments carried out by Dr. Beebe prove with sufficient clearness that alcohol is a toxic substance and not a food in any sense. With regard to alcoholic beverages, Hall has this to say:

Alcoholic beverages contain from 3 per cent to 40 per cent of ethyl alcohol. Beers and ales contain the lower percentages of alcohol; whiskey, rum and brandy the higher percentages, while wines are about midway between.

No alcoholic beverage has so low a percentage of alcohol as to be without danger. The amount imbibed by the addict is usually so much that the alcohol taken exceeds the "physiological limit," that is, there is more alcohol taken than can be oxidized in the liver, so that there is an escape into the general system not only of deleterious toxins, which should have been oxidized in the liver, but also of the excess of alcohol, which is carried to brain and to muscles, seriously disturbing their normal activity and decreasing their efficiency.

The evidence, on the whole, gathered from the views of authorities on tropical hygiene, appears to point in the direction of abstinence from liquor or strict moderation in its use in the tropics. The arguments, however, in support of complete abstention from alcoholic beverages are no more decisive as regards the tropics than they are with respect to temperate climates. It is true that scientific and public opinion are veering towards the view that alcohol is unnecessary and ofttimes very harmful; therefore, it may be stated that when the opinions of various authorities on the subject of alcohol in the tropics have been carefully considered, the preponderant view, at any rate, from the scientific standpoint, seems to be that its use is unnecessary, and, when it is recognized that its abuse is injurious, the best means of avoiding harm is *to abstain from it entirely.*

Among other beverages largely used in the tropics, tea is the most popular, but coffee, cocoa and aërated drinks are consumed largely. The properties of all these beverages have been amply discussed in the section dealing with beverages.

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CHAPTER XIII

DIET IN CRITICAL PHYSIOLOGICAL PERIODS

Old men bear want of food best; then those that are adults; youths bear it least, most especially children, and of them the most lively are the least capable of enduring it.

Diet in Childhood: Early Childhood; Diet for School Children.
Diet during Puberty.
Diet in Sedentary Occupations.
Diet during Menstruation.
Diet during Pregnancy.
Diet during the Puerperium.
Diet during Lactation.
Diet during the Menopause.
Diet in Old Age.

DIET IN CHILDHOOD

In this chapter no reference will be made to the alimentation for the infant, as this will be fully discussed in subsequent chapters. We will begin with early childhood (from the third to the sixth year before school), during which time the child should have four meals each day and a nap in the afternoon. There should be no sudden change of diet during this period, but the proportions of milk should be gradually decreased and mushy cereals increased, and a greater proportion of breadstuffs, cookies, etc., should be allowed. According to the researches of Atwater, at the end of the second year the child weighs about one-fifth as much as the adult, and requires three-tenths of the standard adult ration, the relative excess being due to the fact that the child is growing and depositing tissues and fat. From the third to the fifth year the growing child requires four-tenths of the adult ration; from the sixth to the ninth year one-half, and from the tenth to the thirteenth year six-tenths. From this age on much depends upon the habits and life. For instance, a girl from fourteen to sixteen requires seven-tenths of the adult ration, and a boy of the same age requires a full adult ration.

Early Childhood.—Dr. M. Allen Starr(1) has worked out the accompanying table of the dietetic needs in childhood collected from the actual food consumption by large groups of healthy children.

STARR'S TABLE OF DIETETIC NEEDS IN CHILDHOOD

	2–3 years (28 cases)	3–6 years (12 cases)	4–10 years (24 cases)
Bread	7.5 ounces	10.3 ounces	10.23 ounces
Butter	.98 "	1.08 "	.99 "
Beef	4.6 "	12.1 "	12.46 "
Potatoes or rice	3.9 "	13. "	10.23 "
Milk	32.6 "	48.6 "	38.5 "

Cereals, fruits and eggs should enter largely into the composition of the alimentation of the growing child, and there is no objection to an allowance of a minimum amount of meat. During this period of development, from the third to the sixth year, the child is building up tissue, muscle, brain, bone and gland, and must, therefore, have plenty of protein. Milk, eggs and cereals will furnish these in abundance. At this time, also, the child is acquiring habits, and it should be impressed upon him that the habit of proper mastication is an important acquisition. This can only be attained by necessity. The mother should be instructed not to feed the child on a diet consisting too largely of pultaceous foodstuffs of a semi-liquid character, as these will be swallowed without chewing and thereby become a hindrance to dental development and a possible detriment to the development of the digestive organs. Such a diet leads, in the first place, to imperfect development of the muscles of mastication and the jaws, with the result that the post-nasal space is small and liable to be encroached upon by adenoids, with unfavorable effects upon growth and general nutrition, while in the second place the particles of carbohydrate food will lodge around the teeth and undergo acid fermentation with resulting dental caries. The great necessity for giving the child food that requires chewing cannot be too strongly emphasized. The healthy growing child will get hungry between meals, and if he is doled out soft bread with jam he is pretty certain first to swallow the food with inadequate chewing and, second, to eat more than he needs, overloading his stomach, overtaxing his digestive activities, and perhaps retarding his appetite for the next meal. This point is particularly emphasized by Watson(2), who urges that a child be taught early to develop the art of mastication, which favors the normal development of the nasal and nasopharyngeal cavities which are of

so much importance, for the purpose of respiration and general nutrition.

The cereal foods are of first importance—oatmeal, hominy and samp, thoroughly cooked and served with butter, cream, milk or sirup. Well-cooked farinaceous puddings of all kinds are wholesome and readily taken by children.

Of fresh vegetables the potato is the most popular, and one of which young children will not tire. It may be served boiled, baked or mashed and creamed, but never fried. Fresh cauliflower, cabbage, spinach, asparagus, beans and peas may be allowed, but canned vegetables should never be used when fresh ones can be had.

We fully appreciate the craving of the growing child for sugar, candy and sweets, a demand which must be satisfied. It is far better to do this, however, by the use of sugar in the food than by allowing the artificially colored sweets of the candy manufacturer, which are often taken in excess apart from the meal. Many fruits contain a considerable amount of sugar in an assimilable form, as well as certain mineral properties which are of inestimable value and importance in maintaining a healthy condition of the blood. Apples, peaches, pears, plums, grapes, oranges, bananas, cherries, etc., are suitable wholesome fruits, and some of these, according to season, should form a part of the child's dietary each day.

The first permanent molar teeth appear about the sixth year, while the deciduous incisors are already undergoing decay. Children at this stage require careful preparation of food by fine cutting, scraping, etc. At this time, also, the child should be initiated into the use of the tooth-brush, and if necessary the dentist should be consulted as to the preservation even of the deciduous teeth by means of temporary soft fillings. Not only are these deciduous teeth more valuable for mastication than parents sometimes think, but with cavities they furnish a home for the colonization of bacteria, which hasten the early loss of the permanent teeth.

The normal day's ration for a healthy child of four to six years, according to Hall, may be as follows(3), necessary variations being made in accordance with the season, climate, etc.:

Breakfast—7 A.M.

A glass of whole milk; small portion of thoroughly cooked oatmeal with cream and sugar; baked apple; small piece of buttered toast.

Lunch—10 A.M.

A small portion (equal to a heaping tablespoon) of parched sweet corn, or two graham crackers; glass of water.

Dinner—1 P.M.

Cup of cambric tea (hot water and cream sweetened); bread and butter; creamed potatoes; fruit, stewed or fresh.

Tea—4 P.M.
A dry crust or a piece of cold, dry toast, or a pretzel, or two graham crackers.
Supper—6 P.M.
Glass of milk; soft-boiled egg; shredded-wheat biscuit with cream; fruit (apple, grapes, banana or orange).

There are several points in reference to a child's diet which should be specially emphasized, as pointed out by Hall. First, his food should be dry and hard to chew. Second, one meal each day should be rich in proteins. Third, any lunches partaken of in the midforenoon or midafternoon should be small in volume and should always be dry, requiring very slow mastication, which will insure the ingestion of small quantities and rapid digestion. Furthermore, such a repast will not interfere with the full meal which is to follow some two hours later. A normal child of two years and upwards has a well-developed digestive apparatus and a keen appetite, and is well able to digest most foodstuffs if given in moderate quantities.

Watson has compiled a very practical table of average weights and heights of children at different ages. The averages in these tables were calculated from weights and measurements taken from a large number of observations, and, though fairly accurate, are not necessarily true in all cases. The discrepancy, however, will not vary more than 15 per cent either way. The point of greatest importance is the proportion between height and weight. To be exact in recording observations in weight, the periodical weighing should be done under precisely corresponding conditions, the same clothes, same scales, etc.

COMPARATIVE HEIGHTS AND WEIGHTS OF CHILDREN

Age last birthday	Males		Age last birthday	Females	
	Height	Weight		Height	Weight
1	2 ft. 5½ in.	18½ lbs.	1	2 ft. 3½ in.	18 lbs.
2	2 " 8½ "	32½ "	2	2 " 7 "	25¼ "
3	2 " 11 "	34 "	3	2 " 10 "	31½ "
4	3 " 1 "	37 "	4	3 " 0 "	36 "
5	3 " 4 "	40 "	5	3 " 3 "	39 "
6	3 " 7 "	44½ "	6	3 " 6 "	41¾ "
7	3 " 10 "	49¾ "	7	3 " 8 "	47½ "
8	3 " 11 "	55 "	8	3 " 10½ "	52 "
9	4 " 1¾ "	60½ "	9	4 " 0¾ "	53½ "
10	4 " 3¾ "	67½ "	10	4 " 3 "	62 "
11	4 " 5½ "	72 "	11	4 " 5 "	68 "
12	4 " 7 "	76¾ "	12	4 " 7½ "	76½ "
13	4 " 9 "	82½ "	13	4 " 9¾ "	87 "

A point, emphasized by Watson, and often overlooked at this period of life, is the necessity for adapting the alimentation to the diathesis of the child. For instance, the needs of a child of tuberculous parents, say, at the fifth year, are different from those of a gouty child of the same age. The child of a tuberculous diathesis is usually of comparatively feeble development, shows little muscular activity, is slightly anemic and possibly under size. The principal point in arranging the diet in such cases is to provide the necessary increase in the amount of animal protein, more particularly meat and raw meat juice. The great benefit derived from a properly planned alimentation in these cases is little less than remarkable, but to secure lasting results, the dietary must be religiously continued for many months, sometimes for as long as two years. The following diet list will be found of practical importance and suitable for a child of five or six years, with a tuberculous diathesis. It contains a more liberal supply of animal proteins in the form of milk, eggs, meat, and soup than an ordinary diet, including two pints of milk, and meat foods at least three times daily. This point should be insisted on and continued during the growing period.

DIETARY FOR TUBERCULOUS CHILDREN

First Breakfast—6.30 A.M.
Milk; biscuit and butter.

Breakfast:
Milk; butter; bread; egg; fish or bacon.

Lunch:
Cup of soup (meat stock), or egg flip.

Dinner:
Soup with raw meat; curds and cream; glass of milk; pounded meat and vegetable; stewed fruit cream; glass of milk. Fish, with sauce; potato; custard pudding; glass of milk. Chicken, bread sauce; vegetable; blancmange; cream; glass of milk.

Tea:
Milk; bread and butter.

Supper:
Good meat soup, thickened with milk; or egg; or meat purée; or lentil purée.

The diet for a child of the gouty diathesis should be most carefully regulated, since it is without question that proper alimentation will do much to eradicate the tendency to disease. "The special features in the dietary treatment are (*a*) the necessity of bringing the child up on a strictly lacto-vegetarian diet, red meats of all kinds to be forbidden, or, at most, only allowed occasionally, and very sparingly; (*b*) the importance of a restricted allowance of sugar and of foodstuffs rich in sugar. If a

child with a gouty tendency is dieted along these lines during the period of growth and development, he will be much less prone to develop gouty symptoms in later life."

Diet for School Children.—Growing boys and girls during school life from the sixth year until puberty require a large amount of wholesome, nutritious food (4). During this stage of life the rapid growth and incessant activity of the child continue, and to these is now added the mental work of laying the foundation for an education. In a child that has been wisely brought up under normal conditions and has had a due amount of work, play and sleep, the appetite will be the best guide for the amount of food required. On the other hand, the appetite of a child who has been indulged with too many sweets and highly seasoned dishes, to the exclusion of the plainer, more wholesome foods, and who has been petted, pampered and brought up like a hothouse plant, will not be a trustworthy guide to the food requirements. Children with a debased appetite of this sort, which is, of course, due to faulty feeding at home, had better be sent to a boarding school at once, where the social customs will soon effect a perfect, if at first a somewhat painful, cure. It is not uncommon at this age to have the parent tell us that "Johnny cannot take this and cannot take that food at home," although on physical examination no defects will be found. It cannot be too strongly impressed on parents that the inability of healthy children to take ordinary food is imaginary, brought about largely by previous erroneous feeding and fostered by paternal weakness, proof of which is furnished by the fact that when the child is placed among other children who are eating ordinary food this inability at once passes away. It must not be lost sight of, however, that we not infrequently meet with a neurotic boy or girl with personal idiosyncrasies to certain articles of diet. Such children require special study and special treatment.

The greater the amount of exercise a child takes in the open air, the greater will be his appetite, which will directly influence the quantity of food he should take. Strenuous exercise up to the moment of coming to meals should not be allowed, as such exercise is liable to produce exhaustion, which will affect both appetite and digestion. The normal adult likes to indulge in a short rest after meals, but the healthy child will be eager for exercise, which should not be forbidden, provided it is the nature of the child to be active in play and not easily tired. Still, it is well to remember that a strenuous game of football immediately after dinner is distinctly injurious.

In estimating the requisite caloric value of the dietary of children

some formulæ will have to be followed as a guide. Children of normal size, development and activity Sherman thinks require the following calories per kilogram of body weight.

REQUISITE CALORIES PER KILOGRAM FOR VARIOUS AGES

From 1	to	2	years	100-90	calories	per	kilogram	900	to	1200	calories
2	"	5	"	90-80	"	"	"	1200	"	1500	"
6	"	9	"	80-70	"	"	"	1400	"	2000	"
10	"	13	"	70-60	"	"	"	1800	"	2200	"
Girls 14	"	17	"	65-45	"	"	"	2200	"	2600	"
Boys 14	"	17	"	60-40	"	"	"	2500	"	3000	"

In calculating a dietary for children the factors of growth and development must always be taken into consideration. The child needs protein for the ordinary wear and tear and also requires an additional amount for the production of bone and muscle. The child has an intense metabolism, more general than the adult; owing to the period of growth the food must supply material to be added to the body in the form of bone and brawn in addition to that which is oxidized for normal metabolism.

In selecting the proper alimentation of young subjects, the most important consideration is that of not starving the child on any one foodstuff(5). A requisite amount of protein, fats and carbohydrates is absolutely essential. To stint is very often to starve; therefore, in arranging the diet, the meals should be at regular intervals, at least three good meals being given daily. The chief difference from the feeding in the early years is that a large amount of beef and mutton is now demanded. Meat should be given twice a day, once to provide for the wear and tear of the body, and once to "supply the means for growth," as Dr. Clement Dukes rather quaintly expresses it. It is needless to say that the freshness of the food is a most important consideration. Salted meats and canned meats are useful in supplying variety in the dietary, but if used too frequently they fail to supply the proper amount of nutrition and their continued use becomes monotonous, leading to loss of appetite. Likewise, canned vegetables and fruits are to be considered as inferior to fresh ones for regular use. The question of hours for meals is important. Breakfast should be punctual to allow the child time to eat a good hearty meal, to masticate its food properly, and to have time before starting for school to attend to the bowels. School children are often upset through neglect of this wholesome rule.

The value of a liberal diet during school life cannot be too strongly emphasized. Dr. Watson(2) speaks with authority on the subject, and

the following articles of food are selected from those given by him as suitable at this age:[1]

SUITABLE DIETARY FOR SCHOOL CHILDREN

Breakfast:
This should be the heartiest meal of the day. Begin with a small plate of porridge and glass of milk; follow by an egg or fish, bread and butter, or toast and butter, and tea or coffee, largely made with hot milk; jam or marmalade and oatcake.

Lunch—11.30 A.M.
A dry biscuit and a drink of milk (not hot scones, buns, or pastry); a little fresh fruit, apple, orange, or banana.

Dinner—in the middle of the day:
This should consist of soup, meat, vegetables, and pudding. The soup does not require to be made of rich meat stock—lentil, pea, broth, or rice soup are all excellent, giving a good foundation for the meat course. Roast, boiled meat, and stews are the best, served always with potatoes and a vegetable. Pudding should be varied: suet pudding with fruit or jam, milk puddings, or stewed fruit. A glass of milk may be given with this meal, and as much bread as the child wishes to take.

Tea, not later than 5.30 P.M.
Beverage, milk or cocoa (not tea as a rule); as much plain bread and toast as the child can eat; plain cake; sometimes an egg, or fish, or potted meat, marmalade, jam, or honey.

Supper:
A drink of milk and a biscuit is all that is necessary; a large supper is not advisable. It is better for all children to go to bed with the stomach comparatively empty.

Weak tea and coffee, well diluted with milk, may be added to the dietaries given, but should not be taken in excess. Milk at this age will be made much more palatable and attractive to the palate if flavored with tea or coffee. The question of an allowance of alcohol for schoolboys may be answered by asking the question: "Is it necessary, and is it beneficial?" The consensus of opinion of both physicians and dietitians has decided both questions in the negative. If, then, the use of alcohol by the schoolboy has been considered unnecessary on physical grounds and not beneficial on normal grounds, one can safely assert with confidence that alcohol should not form a part of the youth's diet during school life. (*See* section on Alcohol, Volume I, Chapter XVI, page 568.)

The chief meals of the day should be three in number: breakfast, dinner and supper. The first two should be the substantial meals, while supper should consist of less stimulating food. Under no consideration should schoolboys and girls have a heavy meal of stimulating food a short time before retiring. Neither should they be set to the task of doing lessons in the morning before partaking of food, but should spend a half hour in the open air, after which a substantial meal should be served, with plenty of time for thorough mastication. The dinner hour usually follows four or

[1] For additional dietaries see Volume III, Chapter XXVIII.

five hours after breakfast. For some children this may prove too long an interval without food. If so, a piece of bread with an apple or some light food may be allowed in the midforenoon. The supper should be a light repast, as outlined above, and should be taken some two or three hours before retiring.

It will be admitted that a diet selected from the above list proves amply sufficient, liberal and varied. It should meet all the requirements of the growing body and even the special weakness of the schoolboy or girl in the matter of sweets. Although no mention is made of fresh fruit, this is to be regarded as an essential part of the daily diet, for though its nutritive value is not great, the carbohydrate matter, which is abundant, is in a form which appeals to the youthful palate. The action of fresh fruit on the bowels and the blood renders this food material specially desirable and suitable for growing boys and girls.

The medical inspection of school children has been the means of detecting and remedying many defects which hamper the child in his studies, and it may be safely stated that a child who cannot easily and without physical detriment keep up with his class is defective, due to imperfect vision or hearing, to sluggish respiratory changes due to adenoids, etc., to imperfect nutrition at home, or to some other remediable condition that is more likely to be detected by regular school inspection than by the observation of ignorant and careless parents. With three good meals daily from the above dietary, no boy or girl should suffer from hunger or from failure of nutrition from lack of food.

The superintendent of schools should see that the hygienic condition of the building is such as to favor the working of a pupil without undue fatigue, which might lessen appetite and thereby interfere with nutrition. Tasks should not be imposed that would be arduous for the average child to perform, for the most part during school hours. Neither should the discipline be such as to overtax the child or interfere with his meal hours.

If greediness in partaking of food is observed in a youth, it must be discouraged and checked, as it breeds physical ills if tolerated. However, one must not allow a healthy appetite to remain unsatisfied on the ground that moderation is a desirable virtue. Some parents and the heads of boarding schools consider that the minimum allowance of food compatible with health is all that is desirable, and in many such cases children are kept in a chronic state of starvation. It is true that certain children with strong constitutions, ruddy, rugged and robust, might stand this without ill health accruing, but there are instances where the future growth and development of a child have been permanently stunted by a scanty allow-

ance of food. If at this period of growth and development there must be error, let the error be on the side of allowing the maximum rather than the minimum amount of food.

DIET DURING PUBERTY

The period of pubescence begins in the girl usually about the thirteenth year and the boy about the fourteenth year. This period in both sexes is marked by great physical growth and development, and the dietary, to meet these new demands, should be rich in easily digested proteins. There is no time in man's existence when there is greater need for wholesome, suitable, nutritious food—that which will build up good rich, red blood—than at this period. The adolescent should have liberal allowances of bread, eggs, meat and foods of every kind, provided he digests them well, but highly spiced dishes and wine should be tabooed.

The paucity of reliable statistics on the normal consumption of food in adolescence is a serious drawback to the dietary guidance in the feeding of young boys and girls. It is difficult and unusual to collect the basic facts regarding the functional needs and performances in this period of youth. A recent investigation by Gephart(5) gives an idea of the actual amounts of nourishment ingested by more than 300 boys in one of the largest private boarding schools in the United States.

The total animal supply for such an institution containing 355 boys was computed as follows, in metric tons:

	Protein	Fats	Carbohydrates
Food supply	20.5	25.6	60.5
Waste	3.8	5.4	4.2
Food fuel	16.7	20.2	56.3

The quantity of food computed on the basis of the individual meal served, appears as follows:

	Pounds	Grams	Calories	Calories (Per cent)
Protein	0.1107	50.2	206	14[1]
Fat	0.1332	60.4	562	39
Carbohydrates	0.3717	168.8	692	47
			1,460	

[1] Seventy per cent of this was in animal protein.

The food was of the best quality, and included 193 separate varieties. The cost per meal was 20 cents, or 13.8 cents per thousand calories. This is twice what the poor man in New York City pays for his food. But these growing athletic boys were not satisfied with the conventional 3,000 calories per day. The investigator of their dietary ascertained that beside the 4,350 calories which they consumed daily at the table, they bought 650 additional calories in food at a neighboring store, the principal item being chocolate.

Graham Lusk(6) has pointed out the fact that the 5,000 calories contained in the daily alimentation of active American boys of school age are half again as much as a farmer at strenuous work is thought to require. The total fuel intake of the boarding school just mentioned was three times that necessary for the heat production of boys from 13 to 16 years of age when asleep and resting. As previously emphasized, these findings serve in a way to explain the ravenous appetite of growing boys and girls. Lack of appreciation of this factor and lack of provision for it are a frequent cause of much under-nutrition in children.

The adolescent girl in particular needs good wholesome rich foods, more especially those containing iron. We have already called attention to the iron content of many foods. Lean meat, eggs, and the dark green leaves of vegetables, as spinach, are all rich in iron. A well-balanced rational menu for a fourteen-year-old girl or her sixteen-year-old brother would be somewhat like the following(7):

SUITABLE MENU FOR A FOURTEEN-YEAR-OLD GIRL OR HER SIXTEEN-YEAR-OLD BROTHER

Breakfast:

Oatmeal with cream and sugar; buttered toast; one or two boiled eggs; fruit (grapes, apples, bananas, oranges or berries); coffee, with cream and sugar.

Lunch:

A purée of cream soup with crackers or croutons; bread and butter; fruit; rice pudding or custard.

Dinner:

An ample portion of meat; potatoes (baked or boiled); side dish of vegetables; fruit, stewed or canned, with graham wafers; bread and butter.

This dietary is rich in protein, sufficient to nourish an adult at moderate work. But we must remember that the adolescent has need for a great excess of meat, and, as a matter of fact, the pubescent boy or girl, in school, office or factory, will eat quite as much and often even more than an adult, and will be far more seriously injured if he does not get the requisite alimentation. If a boy or girl craves a light lunch in the mid-afternoon, it should be allowed. A young girl, especially, if she begins to

show signs of pallor, as is frequently noticed in high school girls, may be directed to prepare for herself an egg lemonade, using two yolks instead of the yolk and white of one egg. Such a lunch will not interfere with the dinner later on. The best stimulants of the appetite at this age are fatigue for the boy, from swimming, walking in the open air, and moderate exercise for the girl, tennis and golf, which ought to hasten the return of color to her cheeks.

The craving for sweets by the adolescent boy or girl is a natural one, and should be satisfied. Fudge and other sweets should be allowed, but as a rule it is preferable for these to be eaten immediately following meal time. When partaken of in this manner they serve an important purpose in the alimentation and seldom give rise to any disturbance of digestion. As sweets are the most condensed sources of carbohydrates and per volume are great sources of energy, the insatiable desire for them seems to be more or less instinctive. A few generations back, it was thought and taught that the consumption of sweets had a tendency to produce decay of the teeth, but at the present time the toothbrush brigade has robbed them of any bad reputation which they have possessed in this connection.

The present curriculum in most high schools and girls' colleges is faulty and could be greatly improved upon. Long sessions impose too long and severe a strain on the boy or girl, more particularly if they happen to be puny and with little or no desire for breakfast. A more sensible plan would be to arrange the courses of instruction so that no pupil would be required to attend more than four consecutive periods without a recess. An insufficient breakfast, hastily ingested, due to late rising or to late hours the evening before, either on the part of the pupil or family, so that breakfast is not served in due time, is frequently a cause for digestive disturbances on the part of the pupil, besides furnishing insufficient nutrition. The adolescent attending high school should have a well-balanced midday meal, consisting of good wholesome food. Such an arrangement need not in any way interfere with the full evening dinner with the family. Pupils of this age should be restrained from social dissipation during school sessions except on Friday and Saturday evening.

About this time of life the question of the proper allowance of alcohol, tea, coffee or tobacco, etc., is one that will have to be met and answered. Abstinence from alcoholic liquors is desirable even for the adult, and almost imperative for the adolescent if health is to be maintained. Strong coffee and tea likewise should be shunned. Weak cocoa will afford an excellent substitute for both.

According to Benedict(8), "It should be impressed on the boy or girl

that there are purely physical conditions during the period of growth, as well as differences in the business and social demands upon the adolescent and the adult, which render abstinence necessary in the former, and indulgence comparatively harmless in the latter. If the appeal to judgment based on these grounds is not sufficient, parental discipline may be necessary, and it is even worth considering whether the health of the youth is not worth the argument of example as well as precept. The prejudice against cigarettes, as compared with stronger forms of tobacco, is due almost entirely to their premature use by boys too young to tolerate tobacco in other forms."

DIET IN SEDENTARY OCCUPATIONS

Persons engaged in sedentary occupations which confine them indoors, and whose work is largely mental rather than muscular, require a diet suitable to their needs rather than one adapted to the requirements of a laborer or "lumber jack." Sedentary workers sooner or later realize from experience that they must give attention to their diet if they would remain in good health. If a man whose vocation does not permit of any physical exercise indulges in a heavy diet in which meat is ingested two or three times a day, he is almost certain, sooner or later, to suffer from serious nutritional disturbances. *First,* he is apt to put on an excess of flesh; *second,* his excretory organs, more especially the kidneys, will suffer from the extra strain in eliminating waste products of protein metabolism, with the result that at first he will be annoyed with occasional and later almost continuous disabilities of a rheumatic or a lithemic character; *third,* his digestive organs will sooner or later fag under the burden of overeating, especially of foods from the animal kingdom. As a result he will suffer from constipation, which, if prolonged, will lead to an altered bacterial activity resulting in auto-intestinal intoxication with accompanying stasis and putrefaction. The injurious effects of over-indulgence at the table by the sedentary, are of far-reaching importance, and are claimed to be the chief factor in the development of many serious diseases. There can be no question that the excessive ingestion of protein food induces a temporary albuminuria, similarly glycosuria, pentosuria, etc. The greatest danger from the excessive ingestion of proteins, and more especially animal protein, is due to the fact, as previously pointed out, that they are incompletely oxidized, which tends to the accumulation of waste products in the blood—protein poisons acting injuriously in different directions already mentioned; all of which may easily be avoided by proper alimentation.

Energy diverted for mental work is apt to be at the expense of the digestive process; consequently, it is highly important that the alimentation should be closely studied, so as to exactly meet the requirements of the case, and not unduly tax the organs of digestion nor overwork the organs of excretion. As a rule, meat should be indulged in but once a day, and then only in moderation, while individuals of slender physique and frail constitution will do well occasionally to replace meat by other animal foods, as eggs and fish. Persons engaged in literary pursuits, writers and brain workers, often suffer from lithemia, which in many cases is unquestionably due to other causes than errors in diet—such as anxiety, worry or overwork, "burning the candle at both ends." This class of patients do better on a full diet of good, wholesome, well-cooked food, which is nourishing, light and digestible. They should be instructed to avoid fatty and purely starchy dishes, but they need meat, and it may be allowed in moderate amount. Variety in fruits and fresh green vegetables is also desirable. The following aliments should be rigidly restricted: rich gravies, sauces, custards, patties, lean meat in made dishes, pastry, highly seasoned or fried entrées. The menu for the sedentary, whether professional, literary or business man, should be somewhat as follows (Hall):

SUITABLE DIETARY FOR THE SEDENTARY

Breakfast:

Fruits, preferably a baked apple; breakfast bacon; buttered toast; muffins or gems; coffee with cream and sugar.

Lunch:

A cream soup or purée with crackers, or sandwich and fruit, with a cup custard.

Dinner:

Meat, white bread, potatoes; vegetables; salad; fruit; a light, easily digestible pudding, such as rice, chocolate, or bread pudding with fruit sauce; gelatin or tapioca with fruit; coffee or tea with cream and sugar.

By some this dinner may be thought to be rather heavy, but we will assume that the sedentary gentleman will partake of the different courses rather sparingly; that he will linger long at the table in a social hour with the family in regular deipnosophistic fashion, with quip and repartee, keeping the whole dinner circle in good spirits, which will give him sufficient time to thoroughly masticate his food.

The brain tissue is composed very largely of fat—three times as much as in muscular tissue, while the nerves contain an even greater percentage. Non-lithemic brain workers may advantageously partake of fats and carbohydrates—foods which may be supplied in the form of cream, butter

and well-cooked bacon, bread, potatoes and vegetables. The reason that some writers laud fat as a food for brain workers is the ease with which it is metabolized into energy. The popular idea that fish, owing to the large percentage of phosphorus contained in it, possesses some specific action as a brain food is now an exploded theory. Fresh fish is, however, very wholesome, and by replacing meat in the menu is more easily metabolized by the digestive organs. The sedentary brain worker who desires to keep in a fit condition should have a light lunch and dine late in the day. It is desirable during the active hours of close mental application to supply only the food actually necessary for the prompt production of the requisite energy without borrowing, so to speak, or drawing upon the digestive organs for the expenditure of energy in elaborating food which is only needed for storage.

A tour of inspection of the downtown metropolitan district of any large city at the noon lunch hour reveals two sharply-defined classes of patrons: (*a*) Those who believe in steaks and chops as the best brain and nerve food, and with whom economy is of no moment, and who spend a dollar or a dollar and a half for luncheon; (*b*) those who believe in staying the pangs of hunger for the least money. Members of this class spend ten cents for a piece of pie and some cheese and five cents more for a cup of coffee or a glass of milk, and get just as much fuel value or force and energy as the former—provided, of course, the ingested food is assimilated.

COMPARATIVE LUNCHES

	Proteins	Fat	Carbo-hydrates	Calories
(*a*) Chops	15 grams	20 grams	....	247.5
Potatoes	2.1 "	.1 "	17.7 grams	82
Salad	.5 "	1.6 "	1.4 "	23
Orange ice	....	....	12 "	49
	17.6 grams	21.7 grams	31.1 grams	401.5
(*b*) Mince pie (slice)	6 grams	15 grams	66 grams	436
½ oz. cheese	3.5 "	4.1 "	0.3 "	53.7
½ pt. milk	8.3 "	10 "	12.5 "	178
	17.8 grams	29.1 grams	78.8 grams	668.7

Mrs. E. H. Richards(9) has worked out a daily ration for the sedentary business man, professional man or literary worker, but in our opinion, the protein allowance is entirely too liberal. We give the table below:

RICHARDS' RATION FOR SEDENTARY OCCUPATIONS

Food	Amount	Proteins	Fats	Carbo-hydrates	Calories
Bread	16 oz.	32.0 grams	3.0 grams	258.0 grams	1,216.6
Meat	16 "	50.0 "	30.0 ""	....	481.0
Butter	1 "	....	25.0 "	....	230.0
Sugar	4 "	....	....	110.0 grams	451.0
Milk	8 "	18.0 grams	18.0 grams	22.0 "	329.6
Oysters	4 "	7.0 "	1.0 "	....	37.8
Soup	4 "	4.0 "	3.0 "	....	44.0
Potatoes	6 "	3.0 "	....	38.0 grams	168.1
Eggs	3 "	10.0 "	9.0 grams	....	123.8
Oatmeal	2 "	1.0 "	0.5 "	4.0 grams	25.1
Cream	1 "	1.5 "	6.5 "	1.0 "	70.1
Fruit	8 "	0.5 "	....	50.0 "	207.1
Additional liquid — tea, coffee or water	30 "	....	....	....	......
Total	77 oz.	127.0 grams	96.0 grams	483.0 grams	3,384.2

Contented should be the man whose digestive organs are functionating normally, who is so well balanced that he takes his breakfast, as his newspaper, as a matter of course, and who is no more perturbed by the fraction of variation in the stiffness of his boiled egg than by the rumor of an outburst of Mt. Vesuvius. Happy is he who sits down to the dinner provided for him without thought of what he must partake of and what he must not, with a mind free for social pleasure, secure in the skill and exercise in the culinary department of his household. Who would not strive to have this feeling of self-assurance? And yet how few are willing to pay the price! A little thought, a little self-control, and then forget that there is such a thing as digestion. Blessed be the man whose organs—and especially the organs of digestion—are functionating normally and properly without his being conscious of it. Only in such cases is he a whole man.

Overeating should be religiously avoided by the sedentary individual. We have already emphasized this point (Volume II, Chapter VI), but again we caution against overloading the system with incompletely assimilated foods which obtund intellectual activity and lead to exhaustion of the nervous system. If some arduous task requiring long hours and absorbing concentration and painstaking care is imposed, it will be better to take two light lunches during the day. If the task proves fatiguing, a little Burgundy or white wine may be taken with the lunch. It may, according to Chambers, "stay the weariness of the system and allow the nerve force to be diverted to the digestion of the meal, but to labor on and

continue to take this anesthetic between meals is inconsistent," and "when extraordinary mental toil is temporarily imposed, extreme temperance or even total abstinence should be the rule, for mental activity makes the brain bear less alcohol than rest and relaxation."

The sedentary person who remains much indoors should have frequent week-end outings of two or three days when all the cobwebs may be blown away and all his arterioles flushed out with ozone from the ocean breezes or mountain blasts. The stimulus of change, even if the food is only moderately good, is invaluable.

DIET DURING MENSTRUATION

A perfectly well woman whose menstrual periods recur with clock-like precision need not be treated as an invalid during menstruation, and her alimentation need not be other than usual. Of course it is understood that during the catamenial period she should avoid very cold or very hot baths, and should also shun excessive physical exertion or severe mental strain.

Absence of the menstrual function is a frequent accompaniment of mental disturbance due to great grief, fright or anxiety, while an excessive development of fat may prevent the flow appearing even in persons whose general health appears to be excellent. Here proper dieting will be beneficial. Menstruation may be absent without causing the slightest inconvenience or perturbation; on the other hand, there may be present, coincident with the menstrual period, a feeling of general disturbance accompanied by headache, flashes of heat, nervousness, nausea and vomiting, due largely, if not altogether, to a run-down condition of health, both mental and physical, which appropriate, wholesome, nutritious, nitrogenous diet will greatly benefit.

Various menstrual disturbances may be expected in a certain percentage of young girls, especially during the first year or two following the appearance of the catamenia, which indicate rest, confinement to the room or to bed, and a dietary corresponding to the physical condition of the patient, and to her relative quiescence and environment. Anemia, chlorosis and thyroid disturbances depending on menstruation will receive attention elsewhere.

DIET DURING PREGNANCY

A good, simple, well-balanced dietary is best adapted for the normal pregnant woman, and unless complications arise it is not customary to direct any definite system of alimentation.

As soon as pregnancy is positively determined, the hygienic and dietetic care of the woman should be outlined. First, she should take daily the requisite amount of exercise in the open air; second, too much importance cannot be laid upon the necessity of preventing constipation; third, her alimentation should be regulated to fit her requirements and environment; fourth, gastric disturbances, usually termed "morning sickness," which may or may not be a harassing symptom, must receive attention. If serious vomiting occurs in the early months, the most careful and painstaking attention should be given the dietary. The first principle in the dietetic treatment of vomiting, according to Watson, is to give the stomach a rest. Then the dietetic substances usually prescribed for the relief of nausea and vomiting and for nourishment are indicated, among which may be suggested cracked ice; pancreatized milk, milk with sodium bicarbonate (ten grains); milk and lime water, milk and vichy, soda, seltzer, or carbonic acid water; whey and kumiss; beef extracts and peptonoids; raw meat juice; raw meat pulp; scraped meat; clam broth; dry toast, etc.

The "longings" of pregnant women for various indigestible articles, such as dill pickles, etc., so far as they are kept within reasonable bounds, may be gratified, but there seems to be no reasonable evidence that the refusal to satisfy such caprices has any effect upon the physical or mental development of the child. These "longings" are largely mythical and occur, if at all, only as an accompaniment of a general hysterical condition, and not as a peculiarity of the period of pregnancy.

Albuminuria and dropsy are serious symptoms complicating pregnancy, and their presence demands the most careful attention to the dietary. In these complications the lightest possible diet should be outlined, throwing the least strain upon the kidneys and other glandular organs. In very severe cases it may be necessary to prescribe an exclusive milk diet; in less severe cases a diet of milk, bread, farinaceous foods, and simple fruits may suffice; while in the milder forms of derangement all that is necessary will be to avoid red meats and richer dishes of all kinds and subsist on the lacto-vegetarian diet described in Volume II, Chapter XV.

The quantity of food during pregnancy should not exceed what is usually required by a healthy woman, the meals should be taken at regular intervals, and those articles of food known to disagree should be avoided. The diet throughout the period of gestation should be simple and wholesome but varied. Tea, coffee and alcoholic beverages should be allowed with caution. The vulnerability of the liver raises the question of doubt as to whether ale, beer or stout should be permitted. Large amounts of

meat—more particularly canned meat, canned vegetables, sea food at a distance from the ocean, undrawn poultry and stale eggs, in which decomposition may have already begun, should be avoided also, as should liver, thymus and kidney on account of extractive waste and excessive amounts of purins. Animal foods, even when sparingly taken, force the already congested liver to supplementary work in eliminating toxins arising from muscular tissue, and should be entirely stopped if even traces of albumin appear in the urine. Milk should be discontinued altogether if there are any symptoms of eclampsia. In general, however, cereals, milk, cream and butter, fresh eggs, small amounts of fresh meat—especially poultry and fresh fish, fresh (pod) vegetables, sweet and white potatoes and other vegetables rich in nutriment and with only a small percentage of indigestible residue, and fresh fruits, omitting strawberries, blackberries, blueberries, etc., should be the mainstays of the pregnant woman's dietary.

The idea, formerly prevalent among the laity and to some extent among medical men, that pregnant women should partake largely of foods containing abundant phosphates and lime salts to furnish the embryo with material for the production of bone, is now an exploded theory, since the organic salts in question are plentifully supplied in an ordinary mixed diet.

Another fallacious theory, equally as ingenious, though directly opposed to the foregoing, is interesting only historically. It was once claimed that the agonies of labor would be less severe if the pregnant woman lived upon a diet composed largely of fruits and meat, avoiding fresh vegetables, on the assumption that the lime salts contained in them would favor early ossification of the infant's skeleton and thus add to the difficulties of parturition. It is so well known that Nature is abundantly competent to regulate this process unaided that this theory, like the first, is no longer accepted. However, the size of the child can be, to some extent, regulated by diet. The trend of modern thought, experience, and to a certain extent, scientific research, according to Watson(2), tend to show that scientific alimentation can influence material and fetal tissues in such a way as to make labor more easy and to increase the chances for a viable child being born. This is of special moment to the physician who has under his care a woman with a small or contracted pelvis who has, in consequence of the dangers associated with labor under these anatomic conditions, given birth to one or more still-born children.

Watson records the claims of Prochownick(10) and other investigators who prescribe a diet deficient in carbohydrates and fluids that result in a small child which, in every other particular, is well developed. The

claims of Prochownick are that with a conjugate diameter of 8 cm. a difficult labor can be obviated and the induction of premature labor rendered unnecessary. He suggests that the following dietary should be prescribed, beginning from ten to twelve weeks before labor is expected, and rigidly adhered to, more particularly during the last two months of parturition:

PROCHOWNICK'S ORIGINAL DIET

Breakfast:
Small cup of coffee, 3 ounces; breadstuff, 1 ounce, with a little butter.

Dinner:
Meat, eggs, or fish, with a little sauce; green vegetables, prepared with cream; salad; cheese.

Supper:
Much as dinner—1 to 1½ ounces of bread with butter (water, soups, potatoes, sugar, and beer are strictly withheld).

This average diet consists of:

Protein	140 to 160 grams
Fat	80 to 130 "
Carbohydrates	100 to 110 "
Fluids, about	500 c.c. daily
Altogether a fuel value of	1800 to 2000 calories

According to Watson, polydipsia is complained of during the first few days of this dietetic regimen, but it soon passes off. He also records that some patients complain of the large amount of animal food.

"All the confinements reported were much easier than on former occasions, even when the child was large and fat. All the children were born alive. The children were usually lean at birth, with the bones of the head unusually mobile. They were apparently mature in every way, and in the majority of cases the child gained normally after birth, and the diet had apparently exercised no injurious effect whatever on the child, or on the mother during pregnancy or the period of lactation. On such a diet, it is essential that the condition of the urine should be carefully observed, the amount of urea and the presence or absence of albumin in the urine being specially noted. Unlike what might have been expected, it was found that this diet did not apparently favor the onset of eclampsia." In the majority of instances it has been observed that the child thrived normally after birth, and the diet had no bad effects on lactation.

DIET DURING THE PUERPERIUM

The dietary of the puerperal woman has undergone a revolution during the past few decades. She is no longer kept for ten days upon a diet of toast, weak teas and other "slops," with the idea that semistarvation would lessen the chances of puerperal fever and "milk fever." These changes are largely due to modern obstetric teaching, and to the applica-

tion of antiseptic and aseptic precautions during labor. Immediately after delivery, a woman may be allowed a cup of warm tea or warm milk. Later she may be fed milk, soft-boiled eggs and dry buttered toast; the next few days bread, milk, soup, chops or steaks in limited quantities. She can then gradually return to the diet which she naturally prefers, avoiding, of course, indigestible dishes, as cabbage, fried foods, seed vegetables and, above all, dried beans and other legumes.

Immediately after a prolonged labor the woman is left so exhausted by excessive muscular effort and agonizing pain that she is too tired to eat, and is more thirsty than hungry, so she may have a glass of milk and vichy at this time. As many of the complications of labor, as mania, are favored by exhaustion and inanition, a sustaining and stimulating diet is of the greatest importance. The nursing woman, moreover, requires a more liberal diet than other patients, as her mammary excretion, to furnish the requisite food for the child, must contain a large percentage of protein and fat, and, since she is constantly losing a protein substance in the lochia, she must be full fed or her milk will be poor and insufficient. It is a bad practice to allow a healthy lying-in woman to fast too long. She needs to be well and full fed and will sleep better and feel better than if she receives too little food. While the patient's own appetite is a better guide for feeding than any hard and fast rule that may be formulated, she should be urged to take food unless greatly exhausted, but care must be exercised not to overload the stomach. After the milk secretion has been established and the bowels regulated, she may be allowed a reasonable quantity and variety of food, though while in bed she requires less than later when up and about. Any complication with a rise in temperature is a contra-indication for allowing much animal food, except milk, but extreme exhaustion without febrile action demands it.

DIET DURING LACTATION

The period of lactation usually lasts for about one year, though towards the end of the seventh or eighth month the quality and quantity of the milk secreted begin to fall off. Some mothers nurse their children far into the second year, but the nutritive properties of the milk are, of necessity, very poor.

The diet of the nursing mother must be regulated to prevent noxious substances from passing into the breast milk and to keep her in the best possible condition of health, so that she does not suffer from digestive disturbances. Edgar says(11): "If milk is readily assimilated and does

not tend to constipation, she may drink it abundantly. She may also be allowed gruels, meat broths, meat, eggs, vegetables, and other simple nourishing food. Fruits, even if acrid, are not objectionable if they do not react unfavorably through the breast milk upon the child, and if the mother's digestion is good they serve to keep the child's bowels active. A nursing woman should be given meat as lamb chops, beef and bacon—fish, beans, etc. A reasonable amount of fatty foods in all forms if they are well digested, and cheese, potatoes, bread, rice, green and dry peas and lentils, which excite mammary secretion (but not dry haricot beans). Green vegetables are also allowable, with the exception of cabbage, cress, garlic, leaks, onions, mushrooms, salads and sorrel, which permit noxious substances to pass into the mammary secretion. Rich and indigestible foods and alcoholic drinks, beyond a glass of white wine and a pint of beer or cider, should be avoided." While malt liquors sometimes cause an increased secretion of milk, this is because more fluid is drunk and is not due to any specific action of the drink, and the breast milk is not improved. A reasonable quantity of fluids is beneficial and is necessary to maintain the mammary secretion, but milk broths, soups and plain vichy water are far preferable to beer, ale or porter. Weak tea and coffee in small quantities are not objectionable if the mother craves them. As already stated, a nursing woman should be full fed, but not "stall fed," that is, to excess. Her daily alimentation should furnish her with:

Protein	150 grams	600 calories
Fat	100 "	900 "
Carbohydrates	500 "	2000 "
Total		3500 "

Below is given an allowance for one day's ration as calculated by Gautier (12). The weight of the constituent alimentary principles of the allowance is as follows:

A DAY'S RATION FOR A NURSING WOMAN

Kinds of Food	Weight	Protein	Fat	Carbohydrates
Bread	600 grams	50 grams	5.1 grams	300 grams
Meat	400 "	80 "	28 "	2 "
Beans, peas, lentils	100 "	23 "	2 "	59 "
Potatoes	150 "	2.4 "	0.5 "	30 "
Butter	65 "	0 "	60 "	0 "
Beer, 1½ pt.	....	7 "	0 "	20 "
	1,315 grams	162.4 grams	95.6 grams	411 grams

This ration will furnish fuel energy to the extent of 3,150 calories. The beer may be replaced with a pint of milk, and the meat may be reduced and eggs and fresh vegetables substituted. After all has been said, the best galactagogue is good, nourishing, wholesome, simple food, especially rich cow's milk, not so much because it is milk, but because, on the whole, it is easily digested and readily assimilated and furnishes approximately the right proportion of solids and water needed in the secretion of the mother's milk. Benedict advises withholding all drugs during lactation, more especially laxatives, iodids, mercury, etc., unless there is special indication to medicate the child. In cases where opium, alkaloids, atropin, bromids or any "strong" medicines which act directly upon the nervous system, must be given, nursing should be suspended, and the child fed artificially for the time. The breasts, in the interval, should be evacuated by means of the breast pump, and a twenty-four or forty-eight hour interval should elapse after medication is suspended. Foods which contain volatile substances, onions, garlic, or hypnotic substances, such as lettuce, hops or beer, or meats or fowl that is "high," should not be permitted.

To a limited extent the quantity of the mammary secretion can be increased by the allowance of liquid foods and more water than is habitually taken. On the other hand, it can be reduced by withholding water, or by withdrawing serum from the blood, as, for instance, by purgation. The ingestion of more carbohydrates and hydrocarbons does not modify the milk, but an abundant consumption of *proteins* increases the percentage of *fat,* which is the only ingredient of milk that can be influenced by diet. The protein content can be lessened to some extent if the mother is engaged in any occupation which calls for strenuous daily exercise to the point of moderate weariness.

The influence of diet and exercise upon the secretion of the mammary glands has led Rotch (13) to formulate the following rules:

To increase the total quantity of milk: (*a*) Increase proportionately the amount of liquids in the mother's diet; and (*b*) encourage her to believe that she can nurse her infant.

To decrease the total quantity: Decrease proportionately the amount of liquids in the mother's diet.

To increase the total solids: (*a*) Shorten the nursing intervals; (*b*) decrease the mother's exercise; (*c*) decrease the proportion of liquids in her diet.

To decrease the total solids: (*a*) Prolong the nursing intervals; (*b*)

increase the mother's exercise; (*c*) increase the proportion of liquids in her diet.

To increase the fat: Increase the proportion of meat in her diet.

To decrease the fat: Decrease the proportion of meat.

To decrease the proteins: Increase exercise up to the limit of fatigue.

A nursing mother should cancel social obligations so as not to interfere with the nutrition of her child, and all excessive physical strain and excitement are to be avoided. No engagements which conflict with the regular times of nursing should be made, and only the most pressing demands for recreation or important business transactions should excuse the nursing of an infant in public places.

DIET DURING THE MENOPAUSE

The menopause climacteric, or "change of life," in females is attended by marked disturbances of the nervous system, the precise nature of which is not thoroughly understood, but which are beyond doubt influenced by the functions of the ovaries. The reproductive organs are undergoing a complete change. The caliber of the vessels is shrinking, the blood supply is lessened, and atrophy of the ovaries, tubes and uterus is slowly taking place; even the breasts become flat and shriveled, and other parts lose the form and appearance characteristic of the reproductive period(14).

The menopause(15) occupies about five years—two or three from the commencement of irregularity to the cessation of the menstrual function, and a similar period during which time involution becomes complete and the normal activity of the body is established.

An important point in the management of women at this period of their lives is to forcibly impress upon them the fact that they have no definite disorder, but are merely undergoing a perfectly normal physiological cessation of a function(8), and that, while they are likely to be annoyed with various manifestations of physical and psychic disturbances, they will in all probability pass through the "change" without serious consequences. Even in a normal menopause a multitude of symptoms may be present, such as headache, trembling, flashes of heat, palpitation and shortness of breath, insomnia, nervousness, irritability, nervous depression and "nagging." During its course all physiological functions are weakened, and all pathological conditions aggravated(16). If, however, a woman presents a train of symptoms indicating distinct pathological changes, she should be examined and treated appropriately.

There is usually a marked derangement of the nervous system at this

period, in some instances even affecting the mentality of the patient. The patient may present slight vagaries, a loss of interest in the affairs of life, and in extreme cases melancholia or other forms of a loss of mental balance may be observed. During the "change" the excretions and secretions should be watched; the nutrition should be carefully looked after; waste and repair should balance; dietetic excesses and irregularities should be avoided, and care should be exercised in the preparation and serving of meals so as to appeal to the five senses. The diet should be simple, unirritating and easily digested and assimilated. Meats should be restricted and fresh vegetables liberally consumed. As sugar is apt to set up fermentation in the stomach, candies, preserves, jellies and sweet puddings are to be taken in moderation. Pastry, hot breads, fried foods and rich dishes must be interdicted. The patient should imbibe freely of good spring water, drinking three or four pints daily. Stimulants are to be taken very sparingly and alcohol in any form is prohibited. The patient should lead a regular and careful life, taking gentle exercise in the open air. She should be kept as free from worry, anxiety and mental strain as possible, should be instructed to rest in bed during the menstrual period, and to observe early hours, bathe regularly and keep the skin and bowels active.

It must not be overlooked that certain diseases have a predilection for development at the menopause, such as thyroid disturbances, diabetes, hepatic and renal degenerations. The use of ovarian extracts, after or during the climacteric, is now thought to be of doubtful propriety, yet some clinicians claim good results from the administration of corpus luteum products. If the health is carefully looked after during this period, the pathological conditions will subside, but, according to Tibbles(15), "Negligence and disregard of the physician's advice may result in a serious breakdown from nervous or other causes, and may lead to permanent impairment of the health. Due care as to the alimentation, proper attention to the functions of the skin, kidneys and bowels, a careful mode of life, proper rest and freedom from worry and excitement, will lead to the reestablishment of health and formation of *mens sana in corpore sano.*"

DIET IN OLD AGE

Before discussing the question of diet in old age, it may be well to attempt a definition of old age. By no means can this be reckoned by the number of years a man or woman has attained. There are *old* young men and *young* old men. Premature senility overtakes some individuals, generally of the male sex, at middle age or even before, while, on the other

hand, there are men old in years who retain the physical and mental characteristics of healthy middle age. What then constitutes old age? What are the physical and physiological criteria that go to mark the failing of the bodily powers? For in the case of premature senility it is the bodily powers that have lapsed or are lapsing and not, as a rule, the mental faculties. A philosopher once said that a woman was as old as she looked and a man as old as he felt. While this aphorism is true, old age is perhaps most aptly defined by the statement that "a person is as old as his arteries." This would seem to be a correct explanation of the term old age, for when the arteries have hardened, or are becoming hardened, the "decensus Averni" has commenced. As Allbutt states in his work on arteriosclerosis, we recognize now, all of us, that in the lapse of man's years, one long reckoning of his mortality is, and from all known ages has been, written on the walls of his vessels. We may assume that in primitive man, by external conditions, if not by innate capacity, life was of comparatively brief duration. Domestic animals seem, as a rule, not to live long enough to use up their arteries—or not to live long enough to abuse them—and among these creatures atheroma, although not unknown, has not been commonly observed.

Arteriosclerosis, then, may be taken as the sign manual of decaying physical powers(17), that is, of old age, and the person who has hardened arteries may be termed old. Premature senility is far more frequent under the trying conditions of civilized life than when life is passed under natural conditions. The artificial life of cities, sedentary occupations, the stress and strain of business, and, above all, unhygienic habits of living, of which the most harmful are overeating, errors of diet and too great indulgence in spirituous beverages, combine to place old arteries in young bodies and to shorten greatly the normal span of life. One cannot "burn the candle at both ends" with impunity.

First, it may be as well to deal with the means for preventing old age, and, as it appears to have been decided that diet is the prominent factor in its production, the attempt will be made to show how this is so. According to Allbutt, one form of arteriosclerosis is due to the excessive or relatively excessive consumption of meat and wine, and this form is accompanied by a persistence of high arterial pressure. Conheim recognized high blood pressure and big heart in gluttons. Traube was one of the first in recent times to marshal clinical evidence on "luxus consumption" and to argue the question on scientific lines. Fräntzel followed him, with the theory that with gluttony arose an overcharge of the veins and a fall of centrifugal velocity, which propagated a rise of pressure backwards to the capil-

laries and arteries. The fact must not be forgotten that the arteries of the alimentary tract are among the most muscular in the body and have a very complex nervous endowment—a mingled vasoconstrictor, vasodilator and vagus supply; and in no arteries is medical hypertrophy without calcification so well marked and so palpable. This change, even when absent elsewhere in the system, may be found here. Stengel emphasizes as causes overfeeding and hereditary predisposition, and says that regulation of diet and habits, if it cannot cure, may alleviate the malady even in its advanced stages. Sir Lauder Brunton, Dr. W. Russell and many others are of the same opinion. Allbutt(18) says that we, as other engines, differ widely among ourselves, not only in the quantities of food we need for given work, but also in our capacity for dealing with it economically. For example, a small eater may be a bad metabolizer. He would, therefore, urge that while one man can be gluttonous with impunity, and another on a moderate diet become "plethoric," nevertheless, the average man who indulges his appetite for food and drink, especially if his habits be sedentary, runs no little risk of high arterial pressure and of imperiling the integrity of his arteries. Huchard attributes the spread of arteriosclerosis to the increased use of meat during the nineteenth century. As Fanny Burney neatly put it, "Tharle's miscalculation of his digestive powers ended in apoplexy." Another witty person remarked that a good cook is more to be feared when one is in perfect health than a bad doctor when one is ill. However, whether mere overfeeding apart from a toxemia can raise the blood pressure, as if by a parenchymatous surfeit, is a question as yet unanswered. But we do know that overeating and overdrinking frequently bring about chronic constipation and intestinal stasis, which result, more often than not, in alimentary toxemia. The blood becomes surcharged with the end products of protein digestion—toxic materials—and if this condition be allowed to persist, blood pressure is raised, the arteries begin to harden, the natural powers of the body abate, and, in short, the individual is on the high road to old age.

When discussing overeating and injudicious diet as factors in bringing about untimely senility, it should be well understood that these are by no means the only causes. There are persons who, no matter how much they may abuse their bodies in this direction, still live to be old in years, whose arteries do not harden prematurely, and who, although gross eaters and drinkers, continue to enjoy life. On the other hand, there are spare people who do not eat or drink to excess, yet their arteries harden, they exhibit the symptoms of senility before their time, and become old prematurely. Their metabolism is probably defective. In spite of such exceptional

cases, there is little doubt that errors of diet, in the direction chiefly of self-indulgence, are largely responsible for the great increase of chronic diseases—more frequently than not accompanied by arteriosclerosis—so melancholy a feature of modern life, and that diet does play a part, the importance of which can scarcely be overestimated, in the causation of certain conditions distinguished by hardening of the arteries. Theognis, an old Greek writer, said: "Surfeit has killed more men than famine," and perhaps this saying is even truer to-day than when it was penned. Surfeit helps to bring on old age, and to prevent this occurrence, food and drink should be taken sparingly. As the diet calculated to prevent old age is much the same as that best suited to those who have become prematurely old or who are old, that question will be dealt with when diet for the aged is discussed.

The warding off of old age is obviously of greater concern than its treatment when it has come(19), for after the arteries have become hardened there is no means, medicinal or dietetic, which will bring back their pristine softness and flexibility. Remedial treatment by diet and drugs, mainly by diet, may greatly prolong life, but will not cure the condition. For these very substantial reasons those who are young, and those who lead an indoor life, in particular, should see to it that they exercise a wise moderation as regards food and drink and a due discretion as to the kind of food. Observe a dictum of Hippocrates that "everything in excess is unusual to nature."

With regard to diet in old age, the consensus of opinion of those who have studied the subject is that less food is needed than at other periods of life. In fact, this is not a matter of opinion, but of exact knowledge. In youth we are going uphill, in old age downhill. In childhood and in early youth the physiological powers are concerned with building up the organism and developing its various functions, and an ample supply of food is required to further these operations. In these days the supply exceeds the losses and acts in developing the organism, and the body increases in height and weight. The child or youth can eat, and indeed needs, an amount of food which the ordinary adult would find beyond his requirements. Also during this most active physiological period of life the impaired cells are regenerated rapidly and with ease, and new cells spring up like flowers in the spring and more than counterbalance the decay of the affected ones. Nevertheless, the time comes when the processes of decay and repair are exactly balanced, and the body has reached its full growth or maturity.

On reaching manhood the individual generally acquires the prevailing

dietetic habits of his associates, with little disposition to question their suitability to himself. If he leads an active life and has plenty of exercise in the open air, he may largely exceed, both in quantity and variety of food, what is necessary to supply the demands of his system without paying a very exorbitant price for the indulgence. A "bilious attack" at intervals affords a safety valve and gets rid of the undesirable balance which remains in the case of every hearty eater. In the normal condition of things this state of affairs is maintained for many years. After the first half or so of life has passed away, however, instead of producing these periodical attacks of sickness, the unemployed material may be relegated in the form of fat to be stored on the external surface of the body or to be packed among the internal organs, producing obesity to a greater or less extent. There are some individuals who do not seem to be able to store fat, however rich their diet may be or however inactive their habits. In such persons, and on occasions in those who do store fat, the excess of food material ingested must go somewhere to produce disease in some other form, probably at first interfering with the action of the liver, the next appearing as gout or rheumatism, or as the cause of fluxes and obstructions of various kinds. Gout is, to some extent, a safety valve in the same way as bilious attacks in youth, except that it is really damaging to the constitution and materially injures it. Up to the time of middle age, if a person be robust and vigorous, and possesses a strong digestion, he can convert a large mass of food into fluid aliment suitable for absorption into the system. Moreover, his eliminating powers are active and can pass out of the body superfluous material otherwise destined to produce mischief in some form. As he advances in years, however, his powers of elimination diminish proportionately; less nutriment should therefore be taken, and the kind of food in many cases should be different. A due relation should be preserved between the "income" and "output," and if this be neglected for any considerable time, injury will be done to some of the organs or functions of the body.

It must be remembered that, even if the body be in a healthy condition in normal old age, there is a great difference between the health of youth and that of age. In youth vitality is strong and the recuperative powers are great, the abundant vital forces render the organism elastic so that severe illness does not unduly drain the system, and there is a reserve of energy which can be called upon, and which is generally equal to the demands. In old age there is not this reserve force, the constitution is enfeebled and has lost much of its resiliency, vitality is weak, the spring of youth is lacking and no longer acts with a force equal to that with which

it is expended—in short, the body cannot respond to the demands made upon it as of yore. As Tibbles points out, slight deviations from the normal performance of function occur, which may, however, for a long time be imperceptible. These gradually increase in extent until they become manifest indications of a failure of the bodily powers or of disordered health. Exertion produces results which formerly would not have been noticeable and exhaustion is out of all proportion to the work performed. Among the most marked indications of failing metabolism and consequent disturbance of the functions are symptoms of disorder of the alimentary system. With old age and approaching old age the muscular power of the whole system wanes. The muscular fibers of the stomach and bowels participate in this decline. But, although the digestive powers and those of assimilation diminish, the appetite often remains good, or in some persons the custom of eating and drinking freely is so ingrained that it has become a habit. More food is therefore consumed than can be digested or absorbed, and, as mentioned previously, the unabsorbed portion probably undergoes putrefaction, and in the end produces that condition known as alimentary toxemia; high blood pressure ensues, and arteriosclerosis is aggravated.

The pathological changes incident to age have been summed up by Metchnikoff as a sclerosis which may affect the brain, liver, kidneys and other organs, but is mostly seen in the blood vessels. There are many other degenerative changes, but to mention all of these would be superfluous. Arteriosclerosis is the most important.

Perhaps too great emphasis has been laid on the point that arteriosclerosis is synonymous with old age. We intend to convey by this statement that thickening of the arteries may be considered as physiological old age. It may occur prematurely, when it is termed premature senility, and to a greater or less extent it is generally an accompaniment of advanced years, though by no means always. However, whether the condition be that of physiological old age or of old age without obvious injury of the arteries, the question of diet is all important. In healthy old age, where the organs and functions show only the normal and sometimes but comparatively few degenerative changes, there is, nevertheless, always a certain failing of the bodily powers. There are variations and changes accompanying the progressive deterioration of the organism in which all the organs and functions participate more or less, although it is doubtful, except in the case of definite disease of the excretory organs, whether the aged suffer in any marked degree from their inefficiency. Constipation is usually the most troublesome affliction of senility and the

phagocytes are particularly active. The object, then, should be to discover a means to strengthen the most valuable cellular elements on the one hand, and weaken the phagocytosis on the other. The elixir of life is yet to be found and, therefore, other and more prosaic methods must be sought to achieve this end. While the problem of how to effect this is still far from solution, the consensus of opinion is that judicious eating, combined with hygienic modes of life in other respects, will do most in this direction, and that diet is the main staff upon which to lean.

All are agreed that in old age the diet should be lighter than in younger years, and that the amount of food eaten should vary with the needs of the individual. The food should be of an easily digestible kind, and, according to Friedenwald and Ruhräh, it should be given in smaller quantities at a time, and the intervals between meals should be shortened. Nascher(19), on the other hand, says that the oft-repeated advice that the aged should eat little and often is irrational, for digestion is naturally slower in old age and frequent feedings keep the stomach constantly at work, there being always a mass of food in the stomach in different stages of digestion. This, he thinks, is the most common cause of flatulence, heartburn and senile gastric catarrh, with its attendant pyrosis and gastrodynia. In old age, according to this writer, food should not be taken oftener than once in five- or six-hour intervals, at fixed hours each day. The number of meals, like the time of day at which the principal meal is taken, is a matter of habit, often of nationality, and does not affect the rule.

As at all adult periods of life, if there be a tendency to obesity, food that is apt to be converted into fat should be given in diminished amounts. The proteins should be somewhat lessened from time to time. Some authorities, including Sir Henry Thompson, advocate a vegetarian diet for the old, believing in the proverb, "Much meat, many maladies," but others see no valid reason why animal proteins should not be given in moderation, especially if the subject has been a consistent meat eater. There are those who regard heavy suppers as an abomination. Possibly such meals are blazing indiscretions at any period of life, and certainly in old age they should be most severely condemned. Likewise eating between meals is a habit that is discountenanced, although it is probably less harmful than is supposed. The personal equation with regard to diet and particular kinds of food holds good just as much with the aged as with the person in the prime of life. When an individual has reached the age of 60 years he ought to have learned which articles of food disagree with him, and should refrain from these. A diet laid down on strictly scientific lines

will not suit all old people, and a fairly wide latitude should be allowed for personal likes and dislikes and for individual idiosyncrasies. Especially should monotony in diet be avoided, no matter how perfectly adapted it may seem to be from the laboratory standpoint. Cowper's saying, that "variety is the spice of life and gives it all its flavor," applies with as much truth to food as to other things.

Now it is allowed that food is perhaps the most essential factor in warding off old age, or rather in avoiding many of the disagreeable accompaniments of old age which are certain to occur if the habit of indulging in food to excess or of eating unsuitable viands is persisted in. Dr. Harry Campbell(20) states that in his opinion the most suitable dietary for the aged is that which constitutes the ideal diet for many in general. Such a dietary demands (*a*) moderation in quantity, (*b*) simplicity in quality, and (*c*) the avoidance of those starchy foods which are apt to slip into the stomach without having first been adequately insalivated. A *moderate diet* is one just sufficient—supposing the various foodstuffs, fats, proteins, etc., to be properly balanced—to maintain a person at the slightest weight consistent with the most perfect health of which he is capable. *Simplicity* is constituted by such items as bread, plain biscuits, plain puddings, plainly cooked vegetables, fruit, meat, fowl, fish, milk, Cheddar cheese, tea, coffee, cocoa, salt. Dishes calculated to tickle the palate are not included in the simple diet; neither are alcohol nor condiments other than salt and, occasionally, pepper and mustard. *Avoidance* of soft starchy foods is essential. All through life, starch should, as far as possible, be taken in a form compelling mastication. Soft starchy foods such as puddings are only admissible on condition that they be thoroughly masticated.

The diet of early man conformed to these three requirements. It was simple, consisting as it did of unprepared animal and vegetable substances. The quantity was not, on the whole, in excess of physiological needs; and all the starchy food, being raw, had to be abundantly masticated in order to break up the non-digestible cellulose framework and thus liberate the contained foodstuffs. When we come to compare the ideal with the actual in the present day, the contrast is discouraging. Too often the stomach and bowels are burdened with an excess of food and harassed by a too great variety. Efficient digestion is rarely possible under these circumstances, and the blood is surcharged with nutrient matter, much of which is in an imperfectly digested form. The tissues being thus bathed in an overrich and perverted plasma, metabolism fails to proceed normally and health suffers.

Inasmuch as after early adult life there is a steady waning in the ability of the organism to digest and metabolize the food taken, it follows that the need to conform to the requirements of the ideal dietary becomes increasingly pressing with advancing years.

Campbell elaborates the points which we have touched upon, with regard to the capacity of the organism to cope with different kinds of food, the influence of custom and idiosyncrasy, as well as of age, and his remarks are so instructive that it will be fitting to refer to them at length. As to the first of these influences, while one should be cautious in recommending to an aged person a diet very different from that to which he has for years been accustomed, the experience derived from prisons, workhouses and similar institutions shows that the ability of the aged to adapt themselves to novel kinds of diet is by no means small. It is indeed astonishing what can be achieved in this direction if the necessary pressure be brought to bear.

The factor of idiosyncrasy is important. Individuals differ greatly, quite irrespective of age, in their digestive and metabolic capacities. We meet with children who are unable to tolerate foods which old people can digest quite easily, and with others who are made ill by even a slight excess, while their grandfathers can, perhaps, consume large quantities with comparative impunity. Some old people have, in fact, prodigious powers of digestion and metabolism, and we may look upon them as corresponding in the physiological sphere to the Shakespeares and Newtons in the realm of mind. They are physiological geniuses. Most of these old people would, however, doubtless enjoy better health, be more amiable and have greater consideration for others, on a more abstemious diet; nevertheless, in regulating their food, we must make due allowance for their prodigious powers, though not infrequently, by the gratification of their inordinate appetites they are paving the way for many and diverse complications. If they have high blood pressure and exhibit any of the symptoms of apoplexy, the amount of the food they take should be limited.

According to Friedenwald and Ruhräh(21), milk may be taken in all forms when easily digested, and when it is not well borne the addition of warm vichy or warm water will often prove helpful, or the milk may be diluted with cereal gruels, or have sodium citrate, one grain to the ounce, added to it. Beef tea is often useful, and beef juices may be used if desired. Eggs, lightly cooked or beaten up with milk are very good, as are nutritious soups, such as chicken or fish purées, mutton, beef or chicken broth. Young and tender chicken, game and other tender meats and good quality potted chicken or other potted meats may be taken. Sweetbreads

are easily digested if fresh and properly prepared, but may be contra-indicated on account of the purin nitrogen contained. White fish, such as sole, whiting, smelts and the like, are all suitable, and are best when boiled. Crisp grilled bacon is relished by many.

The following foods are also suitable: bread and milk made with the crumbs of stale bread and without lumps; porridge and oatmeal gruel; puddings of ground rice, tapioca, arrowroot, sago or macaroni, with milk or eggs, and flavored with spices or served with fruit jelly; bread and butter, the latter at least a day old; rusk, to be soaked in tea or milk and water; prepared foods, consisting of predigested starches. At this age digestive ferments are scantily provided by the digestive organs, and soluble carbohydrates are valuable for maintaining the body heat. All farinaceous foods should be subjected to a high temperature for some time during the cooking process, so as to render the starch granules more digestible. Vegetable purées of all kinds may be taken in moderation, *e.g.*, potatoes, carrots, spinach and other succulent vegetables. Potatoes and fresh vegetables are a necessity; if omitted, a scorbutic state may be engendered. Stewed celery and stewed Spanish or Portugal onions lend variety to the diet, and stewed or baked fruits, fruit jellies, and the pulp of perfectly ripe raw fruits may be taken in small quantity.

With respect to a diet for old age based on scientific investigations, Voit(22), who founded his conclusions on researches made by Forster, considered that the conditions of old age indicate a ration of 0.8 the value of that for men and women of mature age, in good health and doing moderate work, as follows:

VOIT'S DIETARY STANDARD FOR AGED PERSONS

	Protein	Energy
Old man, no work	90 grams	2,116 calories
" " light work	100 "	2,689 "
Old woman, no work	80 "	1,831 "
" " light work	85 "	2,096 "

In this standard, as Tibbles points out, no age is stated, and the amount of protein is considered by some authorities to be too great.

Maurel(23) points out that, as age increases, the amount of external muscular work becomes smaller, internal muscular work becomes less, and therefore the nutritive requirements of the body are correspondingly decreased.

MAUREL'S MAINTENANCE RATIONS FOR OLD PEOPLE

Age	Protein per Kilo	Energy per Kilo
Adult	1.5 grams	35 to 38 calories
Fifty to seventy years	1.25 "	30 " 35 "
Seventy years and over	1.00 "	25 " 30 "
Extreme old age	0.75 "	20 " 25 "

Langworthy(24), by using Maurel's maximum factors and taking the average weight of old men and women to be the same as found by Quatelet(25), has framed the following table to show the estimated requirements of aged people:

LANGWORTHY'S DIETARY STANDARD FOR THE AGED AND INFIRM

Subjects	Age	Average	Weight	Protein required	Energy required
	Years	Kilos	Pounds	Grams	Grams
Men	60	65.50	144.1	81.9	1,965
"	70	63.03	138.7	78.8	1,891
"	80	61.22	134.7	45.9	1,531
"	90	57.83	117.2	43.4	1,446
Women	60	56.73	124.8	70.9	1,702
"	70	53.72	118.2	67.2	1,612
"	80	51.51	113.3	38.6	1,288
"	90	49.34	108.5	37.0	1,234

Kosevi(26) found that the food consumed by women aged seventy-six and seventy-eight years was as follows:

KOSEVI'S MAINTENANCE RATION FOR THE AGED

	Protein	Calories
Woman, seventy-six years, 45 kilos, first diet	77 grams	1,361
" " " " 45 " second diet	66 "	1,361
" " " " 45 " third diet	66 "	1,165
Woman, seventy-eight years, 61 kilos, first diet	41 "	1,275
" " " " 61 " second diet	41 "	1,575
" " " " 61 " third diet	67 "	1,207

Guriev of Petrograd undertook some experiments to ascertain the amount of protein required by old people, and to study the metabolism of nitrogen. Five men were selected from sixty-eight to eighty-eight years of age. The three younger were hale and hearty, the two elder somewhat

decrepit. The dietaries were given in each case, the first including meat and milk, the second beef tea, but no meat or milk. The dietaries and nitrogen balance are given below:

NITROGEN METABOLISM IN OLD AGE

	Protein	Fat	Carbohydrate	Calories
First diet (*a*)....	90 grams	42 grams	372 grams	2,296
Second diet (*b*)....	55 "	87 "	385 "	2,615

Age	Dietary	Days	Nitrogen			
			Grams in Food	Grams in Urine	Grams in Feces	Gain or Loss
Man, 68 years	(*a*) Meat 100, milk 250, bread 600, butter 20, sugar 60 grams; tea 1,800 c.c.	5	12.7	8.4	1.0	+4.3
	(*b*) Beef tea 500, tea 1,800 c.c.; potatoes 600, bread 400, butter 70, sugar 60 grams	5	8.9	6.5	.9	+2.5
Man, 74 years	(*a*) Meat 142, milk 500, bread 600, butter 22, sugar 60 grams; tea 1,200 c.c.	10	17.4	14.6	1.2	+1.6
	(*b*) Beef tea 500 c.c.; potatoes 300, bread 500, butter 90, sugar 60 grams; tea 1,200 c.c.	8	10.9	7.7	.8	+2.4
Man, 75 years	(*a*) Meat 100, milk 250, bread 55, butter 20, sugar 60 grams; tea 2,100 c.c.	5	13.0	9.0	1.2	+2.8
	(*b*) Beef tea 500 c.c.; potatoes 600, bread 400, butter 90, sugar 60 grams; tea 2,160 c.c.	7	8.9	6.7	1.8	+ .4
Man, 88 years	(*a*) Meat 100, milk 500, bread 600, butter 30, sugar 60 grams; tea 1,530 c.c.	5	15.1	10.7	1.2	+3.2
	(*b*) Bread 340, butter 120, sugar 60, potatoes 400 grams; tea 1,530 c.c.	5	6.7	4.3	1.1	+1.3
Man, 88 years	(*a*) Meat 100, milk 250, bread 600, butter 20, sugar 60 grams; tea 2,200 c.c.	5	13.7	10.9	1.8	+1.0
	(*b*) Beef tea 500 c.c.; potatoes 600, bread 400, butter 90, sugar 60 grams; tea 2,200 c.c.	8	8.9	8.1	.14	+ .6

The conclusions drawn from the observations were: (*a*) The amount of protein ordinarily consumed by old men may be diminished if an abundance of fat and carbohydrate is taken to replace it. (*b*) The assimilation of nitrogen by old men is somewhat less than normal. During the first

dietary the assimilation of nitrogen averaged 91.15 per cent; in the second diet period, 86.17 per cent. The assimilation of nitrogen by young men on a similar diet was found to be 94 per cent. In the first, or meat period, the ratio of incompletely oxidized products to urea in the urine was greater than normal; therefore, the metabolism was inferior to that of young men on a similar diet. In the second, or non-meat period, this ratio decreased somewhat. When the diet contained less protein, but an abundance of fat, the subjects maintained their usual weight and health.

The recent researches of Schlesinger and Neuman upon the digestive functions of thirty healthy individuals over sixty years of age have demonstrated that while starch and fat are thoroughly digested, the digestion of meat is, as a rule, imperfect.

According to Munk and Ewald(27), a man doing no work requires the following amount of food:

	Protein	Fat	Carbohydrates
Man..................	90 grams	40 grams	350 grams
Woman...............	80 "	35 "	300 "

If this be translated into ordinary articles of diet, it would mean: Meat, 80.3 grams; milk, ½ pint; bread, 10 oz.; biscuit, 2 oz.; butter, 1 oz.; potatoes, ½ lb.; sugar, ⅔ oz.; wine, 6⅔ oz.; coffee, 14 oz.

Von Noorden(28) has suggested the following scale for the reduction of the fuel value of the dietary of the aged:

Age in Years	Percentage of Reduction
60–70..........................	10
70–80..........................	20
80............................	30

Saundby, in his book on "Old Age, Its Care and Treatment," says that the diet of the aged should be reduced in amount in proportion to their inactivity. So long as they can work, or take active exercise, they may enjoy the diet of adult life, 35 calories per kilogram of body weight, but they should be careful to avoid large meals and indigestible food. On account of their defective teeth all food should be easily masticated, as, for example, minced or pounded meat and vegetables in purée. The diet should contain few toxins, especially purins; a little meat once a day may be allowed, preferably at the midday meal, while eggs may replace meat at the evening meal. But little alcohol is required, but plenty of water should be taken. Little salted food should be given, as we are ignorant of the conditions in which chlorids are eliminated.

Old persons leading more or less vegetative lives require a smaller amount of food than active adults. We may take it that 30 calories per kilo is a sufficient basis for their dietaries, and if they are obese they should do with less, as fat ought not to be reckoned in estimating the fuel requirements. Saundby thinks these 30 calories might be made up by 1 gram per kilo of protein, 1 gram per kilo of fat, 4 grams per kilo of carbohydrates, so that an old person weighing 70 kilos or 140 pounds might be allowed 70 grams of protein, 70 grams of fat and 280 grams of carbohydrates, which would give a little over 2,000 calories as against 2,450 calories for an adult of the same weight leading a moderately active life. Thus the daily dietary might be composed of the following articles:

SAUNDBY'S DAILY DIETARY FOR THE AGED

Amount of Food	Protein	Fat	Carbohydrate	Calories
Bread, 250 grams (8 oz.)	22.08	3.12	127.4	640
Milk, 568 grams (1 pt.)	17.9	19.6	26.88	375
Tapioca, 45 grams (1 oz.)	0.3	0.0	36.0	150
Sugar, 30 grams (1 oz.)	0.0	0.0	29.2	120
Potatoes, 120 grams (4 oz.)	1.8	0.12	24.0	105
Lean meat, 100 grams (3⅓ oz.)	27.0	7.0	0.0	185
Fat bacon, 30 grams (1 oz.)	2.6	20.75	0.0	187.5
Butter, 30 grams (1 oz.)	0.21	24.3	0.15	270
Total	71.89	74.89	243.63	2032.5

Tea and coffee, beef tea and bouillon, green vegetables and fruit in moderation contain so little heat-forming substances that they may be left out of account, but may be added to the diet.

It will be pertinent to the subject in hand to interpolate some rules as to the feeding of the aged, and a diet table compiled by Dr. Reynold Webb Wilcox(29). 1. Never less than five hours between meals. 2. No solid food between meals. 3. Principal meal near midday. 4. All meals to be as dry as possible. 5. Avoid food likely to cause flatulence. 6. Not more than 5 oz. of fluid with each meal. Alcohol only for those who are accustomed to its use—½ oz. of brandy or whiskey in three or four ounces of water, a single glass of port or sherry.

Breakfast, 8 A.M.:

Small slice of toast, 1½ oz., with butter; one soft-boiled or poached egg, or half a small haddock or other white fish; 3 to 5 ounces of tea or coffee with cream and sugar; tea may be replaced by cocoa or milk with hot water; well-boiled oatmeal, 3 to 4 ounces with 4 to 5 ounces of milk may be substituted for tea.

Dinner, 1 P.M.:

Two courses fish or meat; pudding or fruit; white fish, short fiber, boiled, steamed or broiled half; small chicken, white meat or sweetbreads; game, lamb, small potato boiled or baked or a small portion of spinach; pudding, a simple milk pudding, or rice, sago, tapioca or suet; fruit, as ripe pears, apples, grapes, 4 to 6 ounces; hot water to be taken if desired.

Tea, 5 P.M.:

Tea with cream and sugar but no food; in place of tea, a teaspoonful of solid beef extract in hot water may be taken.

Supper, 7 P.M.:

White fish and one potato or toast with butter. Milk pudding or bread and milk.

10 P.M.:

Five ounces of hot water to be sipped. For the relief of thirst, beef tea or hot water, to be sipped four hours after each or the principal meal.

Saundby, in order to illustrate the distribution of the amount of food in his table still further, suggests the following arrangement of meals:

SAUNDBY'S DAILY DIETARY FOR THE AGED SHOWING DISTRIBUTION OF MEALS

NO. I

Breakfast	Dinner	Tea	Supper
½ pint of tea	3⅓ oz. meat	½ pint of tea	10 oz. milk
3 oz. milk	4 oz. potato	3 oz. milk	1 oz. bread
¼ oz. sugar	1 oz. tapioca	¼ oz. sugar	
3 oz. bread	4 oz. milk	3 oz. bread	
½ oz. butter	½ oz. sugar	½ oz. butter	
1 oz. bacon	1 oz. bread		

NO. II

½ pint coffee	6 oz. fish	½ pint tea	10 oz. milk
1 oz. oatmeal	4 oz. potato	3 oz. milk	1 oz. bread
6 oz. milk	1 oz. milk	¼ oz. sugar	
¼ oz. sugar	1 oz. butter	3 oz. bread	
½ oz. butter	Stewed fruit	½ oz. butter	
3 oz. bread	½ oz. sugar		
	1 oz. bread		

Another dietary for an old person of seventy, weighing from 120 to 140 pounds, affording 1,950 calories, would contain:

47	grams	albumin
314	"	carbohydrates
54	"	fat
20	"	alcohol

Such a diet may be thus distributed:

Morning meal:	
Milk	8 oz.
Sugar	2/3 oz.
Bread	2 oz.
Butter	1/6 oz.
Midday meal:	
Bread	3 oz.
Meat or fish	2 oz.
Vegetables or fruit	2 oz.
Beer	1/2 pint
Evening meal:	
Bread	3 oz.
Eggs	2 oz.
Light pudding	4 oz.
Whiskey	1/2 oz.

The caloric value of a diet may be raised easily by adding to the fat in the form of butter, cream, fat bacon, suet pudding or cheese. With regard to cheese, it may be said that a plain, good, wholesome cheese is peculiarly well adapted as a food for the aged. It is palatable and nutritious and, while it requires sufficient mastication to produce insalivation, it can be readily masticated by the toothless or by those who lack their full quota of teeth. Cod-liver oil, when it can be taken, is useful, as half an ounce of oil daily will afford approximately 150 calories. After fat come the starches and sugars. Cane sugar, as almost pure carbohydrate, can be tolerated in only small quantities. Old men who have been meat eaters, drinkers and smokers, have lost their taste for sweet things, and, in fact, often have a distaste for them, but this aversion can be overcome. Cane sugar is nourishing and by some British authorities is highly lauded in the treatment of arteriosclerosis. It is better assimilated if cooked, as in milk puddings or added to fruit well stewed. Raw sugar should be viewed somewhat askance, as it is likely to upset the digestion, but small quantities will do no harm. Perhaps as much milk as can be digested without discomfort may be taken, but a pint daily is sufficient. Sour milk of late has been given great prominence by Metchnikoff, and is undoubtedly useful in old age. If too sour for the palate, it may be sweetened with sugar, honey, jam or treacle, and may be added to porridge, hominy, boiled rice, or to any breakfast food. It is especially valuable, being slightly laxative, in cases of chronic constipation, the greatest bane of old age. Metchnikoff recommended its use on account of its power of diminishing the toxicity of the bowel contents, and thereby pre-

venting those senile degenerative changes which he deems largely the result of intestinal intoxication. Buttermilk is also valuable when whole milk cannot be properly digested. The casein it contains furnishes its nutritive value, but its caloric value is on the average only about half of that of milk. Kumiss or kefir when fresh acts as a laxative. It is easily digested and highly nutritious in large quantities from a pint and a half to three pints daily.

Campbell(30), who is the chief prophet of thorough mastication and spare living, points out that the appetite for plain food may continue to extreme old age. At one of the large London workhouses the daily diet for men over 60 years of age is as follows: Bread, 20 oz.; margarin, 1 oz.; sugar, 1 oz.; meat, 4 oz.; potatoes, 8 oz.; greens, 4 oz.; pudding, once weekly; stewed fruit, once weekly; tea, 2 pints; salt and pepper daily; mustard once a week; no alcohol. Campbell says that the inmates consume it all and enjoy it thoroughly, complain very little of indigestion, and, what is more surprising, suffer little from constipation.

The alimentary pastes have high food value and are easily digested if cooked simply. Thus they are eminently suitable as a diet or part of the diet of old people. According to Combe, they are composed of the gluten of wheat with a considerable proportion of starch, and are of especial value in the dietetics of intestinal diseases. Not only is the nutritive value of these foods high, but they are cheap. They cost but little more than rice, sago and tapioca, and have at least double the nutritive value.

ALIMENTARY PASTES: FOOD VALUE

	Protein	Carbo-hydrate	Fat	Calories per 300 Grams
Macaroni	12.15	74.58	0.78	340
Vermicelli	12.82	70.78	0.74	335
Italian Paste	12.31	75.16	1.95	345
Rice, boiled	2.77	27.33	0.07	119
Tapioca	5.40	87.18	0.19	350

With regard to the question of allowing old people tea, coffee or cocoa, opinion is divided. Coffee and tea are barred by some authorities as possessing no food value and as containing a poisonous principle—caffein, theobromin and, on occasion, a considerable amount of tannin. They delay digestion, and when tannin is present in relatively large quantities they tend to irritate the mucous membrane of the alimentary tract. They stimulate to some extent the heart and nerve centers. Thus, the case

against the use of such beverages for the old would seem at first thought to be very strong, yet when we look at the other side of the mirror and consider that the drinking of tea or coffee is a life-long habit and, like all habits, hard to discontinue, our view is somewhat modified. However, there are many harmful habits which it is wise and expedient to break, and if it were proved beyond the shadow of a doubt that either tea, coffee or cocoa drinking really injured old people, then our advice would be not to take any of these infusions or mixtures. But when these beverages are of good quality (in the case of tea that variety which contains the least amount of tannin) and prepared with care, we are of the opinion that the harm done, in the majority of instances, is counterbalanced by their pleasure-giving physiological effect. They are indulgences, it is true, and stimulants in a slight degree, and should only be taken in strict moderation by those elderly people who have been accustomed to their use all their lives, and who suffer no inconvenience from their use.

The condition of the teeth of the aged is a matter of much importance and is not infrequently responsible, to some extent, for some of the digestive troubles from which they suffer. This loss or partial loss of the mechanical means provided to man for masticating his food is regarded in different lights by different authorities. Sir Henry Thompson is of the opinion that "the disappearance of the masticating powers is mostly coincident with the period of life when that species of food which most requires their action—namely, solid animal fiber—is little if at all required by the individual. It is during the latter third of his career that the softer and lighter foods, for which teeth are barely necessary, are particularly valuable and appropriate, and the man with imperfect teeth who conforms to nature's demand for a mild non-stimulating dietary in advanced years will mostly be blessed with a better digestion and sounder health than the man who, thanks to his artificial machinery, can eat and does eat as much flesh in quantity and variety as he did in the days of his youth.

Campbell takes an opposite view. He points out that people who have no teeth at all are often better able to masticate than those with a few only, for in the former case the gums are allowed to come together and harden, enabling them to cope with many kinds of food, whereas if the mouth is furnished with teeth, no two of which are opposed, they are useless for purposes of mastication. He says that though the former argument seems plausible enough, prima facie, when examined critically, it will be found to have no basis in fact. If senile edentation has any biological meaning at all, it indicates not that nature desires a return to the diet of infancy, but rather that the time has come to cease eating altogether and to lie down

and die, for under natural primitive conditions the lack of teeth implies death from starvation. Consequently, properly fitting teeth cannot but be of very great advantage to the aged.

The latter argument seems to us stronger by far than the assertion that because in old age teeth come out it signifies that they are no longer needed. Mastication, if not so essential in old age as in the adult period, is yet a valuable power to possess. If food, carbohydrates in particular, is not masticated, it is not sufficiently insalivated, and digestion thereof is hindered and stomach and intestinal troubles are certain to ensue. Moreover, a mainly pap diet, consisting largely of soft starchy food, is not the kind of diet to suit a healthy or, indeed, even a somewhat feeble old person who has been in the custom of eating heartily of more substantial fare. We agree with Campbell that thorough mastication is good for the old, for, be the diet mainly protein or carbohydrate, mastication and insalivation are aids to proper digestion the importance of which can scarcely be overestimated. We agree, too, with Thompson(31) that the old do not require their teeth to consume as much animal protein as they were accustomed to when in full vigor of manhood, for they most assuredly need, as a rule, but a limited amount of animal food. Campbell, however, is in favor of a simple diet with not a large amount of animal protein throughout life, and indeed sees no reason to differ the dietary of healthy old age and adult life to any great extent.

The consumption of meat in old age is still in some degree a mooted question. There are many of the opinion of Sir Henry Thompson, who hold that at any period of life the use of meat should be limited, and others, like Campbell, who believe that to be full fed throughout life is in the best interests of good health. There are yet others, like Woodruff, who think that no particular stint of animal food is necessary. As a matter of fact, it is impossible and would be presumptuous to lay down any rigid rules of diet in order to prolong life. Heredity is one of the most important factors in the attainment of this consummation, while diet undoubtedly is of the first significance and of special import in advanced age. Scientific investigations and observations and practical experience have both taught that less food is needed after a certain age has been reached and that the ingestion of meat should be diminished. Nevertheless, a great deal depends on what kind of life is led. If active and fairly strenuous, a person, although old, requires a sufficiently generous amount of food, and if he is accustomed to eating meat, the amount should not be unduly restricted. In most cases it is advisable to reduce the amount of animal food to one-half of that consumed by people

in middle life. Certain it is that, if arteriosclerosis has made much headway, very little meat should be eaten. Allbutt says on this point that the sum of the argument is, so far as butcher's meat and arteriosclerosis are concerned, that certain observations which we owe to Abelous and others offer evidence with some clearness to show that one or two definite and separable crystalline products produced by bacteria, especially by a specific bacillus of the colon group, can affect the blood pressure.

Dietetic restrictions are obviously indicated in the bronchitis of the aged. Many of such patients are allowed to die through carelessness in diet. As Campbell shows it is not merely that overeating begets bronchitis. The bronchitis and the emphysema that goes along with it curtail the respiratory capacity, and so prevent the excess of food from being burned off. In fact, the only hope of saving the obese bronchitic patient is by a systematic semistarvation.

Campbell(30) thinks that for elderly and aged gourmands it is generally even more necessary to cut down the allowance of starch and sugar than animal food, although this should also be curtailed if excessive. All appear to be agreed that alcohol in any form is of little value in the diet of the aged, and should never be taken when a high blood pressure exists.

The warding off of old age, and more particularly the warding off of premature old age, can perhaps in the majority of cases be effected by careful diet. But it must ever be remembered that as there are all sorts and conditions of men, so there are all sorts and conditions of constitutions and idiosyncrasies. Some, whether they eat sparingly or profusely, suffer from digestive troubles and are apt to grow old prematurely. They are bad metabolizers. This class is not a very large one, and even with them life may be prolonged by paying extreme attention to their alimentation. Again there are those who possess sensitive stomachs and whose digestive processes are easily upset, albeit they may be sound in constitution. These are generally persons of nervous temperament, who, if they exercise care in their dietetic regimen, may live to be very old. This type, like creaking gates, lasts longest. Then there are the hale and hearty individuals who by reason of their robustness and strong digestive and assimilative powers, eat and drink to excess, and who frequently by so doing bring their lives to an abrupt end. As a rule, the moderate eaters and drinkers live the longest.

Yeo(32) gives the following useful suggestions in regard to the diet of the aged:

Any sudden changes in diet should be avoided, and the intervals between the ingestion of food should not exceed six or eight hours.

It is very common for elderly people to awaken early in the morning, at three or four o'clock, and to be unable to drop off to sleep again, but if they have some light form of nourishment at the bedside, such as a glass of milk or a little gruel, which they can take at that time, they will often continue their sleep.

The acidity of certain stewed fruits may be advantageously neutralized by the addition of a little bicarbonate of soda, so as to avoid the use of a large quantity of cane sugar, as this is apt to cause gastric fermentation and acidity. In stewing fruit, about as much soda as will cover a shilling should be added to each pound of fruit.

Aged persons often require their food to be accompanied with some kind of condiment, which promotes their digestion and prevents flatulence. Caviare and the roes of smoked and salted herrings are of this nature.

For sweetening food, milk sugar is much less prone to excite acid fermentation than cane sugar.

A very digestible form of fat—when it is needed—is cream, mixed with an equal quantity of hot water and about ten drops of sal volatile to each fluid ounce.

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CHAPTER XIV

HYGIENE OF THE INTESTINES

William P. Cunningham, A.M., M.D.

General Considerations.
Chronic Intestinal Stasis; Diseases Due to Chronic Intestinal Stasis; Considerations of Diet in Chronic Intestinal Stasis; Hygiene of the Intestinal Canal.

GENERAL CONSIDERATIONS

The subject of this chapter has a great deal broader scope than would appear upon cursory examination. The hygiene of the intestinal tract has a deeper significance than the relief of certain local disturbances, dependent upon the imperfect evacuation of the lower segment. It has to do with problems of a grave and far-reaching character. To appreciate this, it will be necessary to recall the construction of the abdominal viscera with especial reference to the matter of drainage.

We shall content ourselves by simply recalling that the human being is a hollow organism from the mouth to the anus. There exists, then, a continuous membranous tube with dilatations and constrictions demanded by the exigencies of the situation. The pharynx, the esophagus, the stomach, the small and the large intestine vary in size, but constitute one continuous canal. Anything that enters at the mouth, must exit at the anus unless absorbed in transit. It is obvious that for the proper functioning of such a tubular organ, there must be an unobstructed right of way. Any unusual constriction anywhere in its course may convert it into "no thoroughfare" and induce a train of consequences of the most surprising and deplorable kind. The numberless evil things that accumulate in the progress of a more or less thoroughly digested mixture from the stomach to the rectum, may be detained by abnormalities of the channel, until they have accomplished various toxic reactions and been absorbed into the general circulation. Locally also they produce irritations of a serious nature.

An uninterrupted fair way would in all likelihood have been maintained had man not risen from the posture for which he had originally been designed. Going on all fours, his intestines swung free from their mesenteric attachments to his spine. There was no danger of kinking, fouling or jamming of the various loops. The chylous tide swept on with perfect freedom to its destination. But when in the assumption of his new-found dignity he proudly drew himself erect, the relation of the gut to its attachments was entirely altered. It now dragged upon a mesentery clinging to a perpendicular support and was thrown into unpremeditated disarray. It sustained "strained relations" with its environment.

As the advance of man in the refinements of civilization entailed increasing impairment of the muscular energy of his aboriginal forbears, he began to experience the inevitable results of the faulty position of his abdominal contents. Debility, disease, corsets, gluttony, sloth, obesity, caused the prolapse of the imperfectly secured intestines, and they sagged into feeble pouches, incapable of adequate peristalsis, and making a constant traction on the contiguous sections. Nature, ever conservative, strove to offset this injurious derangement by passing supporting bands under the dragging loops. As frequently happens, nature overreached herself. The new supports became added elements of danger and distress. The weight of the prolapsed portion caused an angular distortion at the site of the supplementary slings, for all the world as if one hung an empty hose over a fence. Against this added obstruction the already fatigued intestine struggled with diminishing success. The accumulation behind the obstruction steadily increased, while the gut in front was empty and collapsed. Here was established what Sir Arbuthnot Lane has so aptly termed a cesspool, and in that cesspool are generated, as in the most productive culture medium, a

FIG. 6.—CASE X. INFLAMMATORY, SUPERIMPOSED UPON EVOLUTIONARY STASIS. Lane's band, with potential kink; prolapsed transverse colon, ascending colon, and sigmoid; Jonnesco's fold; Jackson's membrane. Three sets of firm fibrous bands, just below ileocecal valve, extend from ileum to right iliac fossa, one to right ovary.

host of microbial invaders whose varied activities are responsible for most of the ills that flesh is heir to. This is no overdrawn or fanciful picture. It is a plain statement of truth susceptible of the completest corroboration.

No fact in medical practice is of more ancient usage than the effort to overcome constipation. The evil of the inactive bowel has ever been recognized. "Make a hole through" was the homely dictum of the old schoolmen. In this injunction they epitomized the whole question of intestinal stasis and adequate drainage. They did not comprehend the causes at work in preventing this essential function. They attributed to many agencies, conditions which we have found largely confined to one. They talked of diet and torpid liver and insufficient exercise and defective innervation, and they sometimes cured a case where such factors had brought about a fecal blockade in the rectum. But they realized that the failure of the bowel to empty itself created a pathological situation of serious import which demanded all their science to remove. It constituted the stopping of a sewer with a backing up of its deleterious contents. No discrimination was made between the massing of dried effete detritus of a comparatively harmless character in the part of the tract least provided with absorbents, and a fluid compound of putrescent material stagnant at the gaping mouths of numberless lymphatics. The lower bowel could be emptied; its repacking could be prevented. Diet, exercise and laxatives were all-sufficient here. Just a little care and watchfulness achieved the desired result and made the reputation of some wonderful cathartic.

FIG. 7.—E. B., FEMALE, 30, SINGLE. Lane's band; ileal stasis; appendix and ovary caught in band; cæcum dilated.

But of the organic barrier above, of the angular kink, of the sacculated cesspool, they had no glimmering, and consequently could not intelligently direct their therapeutic fire. It remained for the adventurous English surgeon, Sir Arbuthnot Lane, to discover the obstructing abnormality, and boldly proclaim it to a skeptical profession. So ill was his

evangel received by rock-ribbed conservatism that he was hooted out of his scientific societies. He was thrust outside the breastworks by his English confrères, and stigmatized as something uncanny and unclean. It was only when he appealed to the surgeons of America that he began to make impression on the general incredulity. He proved his case and the repute of his success traveling back to the slower innovators at home, rehabilitated him in the good opinion of his own people. The doubt, reproach and derision with which he had been originally received gave place to confidence and respect.

CHRONIC INTESTINAL STASIS

Chronic intestinal stasis due to mechanical obstruction was firmly planted in the pathology of advanced medical thought. Not that all opposition to the idea has been overcome. While man has power of cerebration, differences of opinion will persist. It is impossible to break down the adamantine resistance of prejudice and conceit. Both will hold out against the plainest evidence of their erroneous attitude. But men of ordinary sober judgment, comprising as they do the great majority of our confraternity, are susceptible to conviction and ready to yield assent upon presentation of the facts of the case. So while we occasionally hear a protesting note from some lofty pinnacle, while some eagle flaps his wings and declines to see anything but his own reflection in the sun, while some bird of lesser quality croaks his envious disapprobation, the dissonance is swallowed in the chorus of approval arising from the level-headed searchers after truth. True to its etymology, stasis has come to stay; we mean only in the etiological sense and not in the sense of an incurable condition.

FIG. 8.—J. S. CHRONIC INTESTINAL STASIS, WITH VERY BROAD BAND ANGULATING DUODENO-JEJUNAL JUNCTION. Dilated duodenum; band angulating duodeno-jejunal junction; collapsed jejunum.

In order to intelligently treat an anatomical distortion of this character, thus mischievously situated, it is incumbent to grasp clearly not only

all the demonstrated consequences but also the inferential and rationally deducible conclusions in the premises. Before we may suggest measures of relief, we must be able to show wherein the economy is at fault. Having established the fact of chronic intestinal stasis, it was necessary to associate it with degrees of disability and danger sufficient to warrant radical interference. This has been accomplished. It is maintained by eminent authorities that intestinal putrefaction conduces to brevity of existence. Where actual disease is produced thereby, this is undeniable. Where no such disease is definable, we must rely upon our reason to supply the explanation.

It is unquestionable that the constant absorption of poisonous elements into the general system must put upon it a Sisyphus' task of elimination. This taxes the arterial capacity to the utmost. The vessels are working at high pressure all the time and eventually undergo permanent changes for the effectual performance of the exaggerated function. The kidneys respond to the increased demands of the throbbing arteries by a temporarily raised efficiency, which is followed as a matter of course by a steadily growing deficiency and a speedy termination of the career of the organism. This is deduction, and seems to be borne out by numerous observations.

FIG. 9.—C. O. CHRONIC INTESTINAL STASIS, WITH MARKED DUODENO-JEJUNAL KINK, CAUSING DISTENTION OF DUODENUM. Bands, causing duodeno-jejunal kink; jejunum; stomach; dilated duodenum.

We are quite persuaded also that many of the maladies for which we have no satisfactory etiology can be traced to the pestilential puddle in the sacculated gut. No man knows the extent of the chemical combinations therein effected. All the circumstances are favorable for the unimpeded development of deleterious bacteria and alkaloidal poisons of variable virulence. Shortly after eating clams, men have died with symptoms of acute toxemia. Here the poison was undoubtedly introduced with the clams. But such an article eaten fresh and coming partly digested into a prolapsed, distended and disabled intestine (to fester and rot in the heat and moisture), would be perfectly capable of achieving the same appalling result. Steadily surging forward through an unobstructed chan-

nel, the putrefiable matter would have quickly reached a region where absorption was tardy and the danger practically negligible. The plumbers put "traps" in the course of their waste pipes to prevent the ascent of poisonous gases from the sewer. This word might be fairly applied to the fallen sections of hollow viscera constituting the pathology of stasis. They are veritable "traps" for the retention of the deadly excrement seeking an avenue of escape. This slight play upon words will serve to impress the real conditions back of most of the cases of intestinal putrefaction. It is doubtful whether putrefaction of any considerable degree could take place in an intestine operating with unhindered peristalsis. Nature is able to take care of much excessive material if she is not crippled or deformed.

Diseases Due to Chronic Intestinal Stasis.—The great English surgeon who blazed the trail that has brought us to such a land of hope and promise, claimed to have proved the causation of many grave affections in the toxic reactions of the delayed ileal effluent. Diabetes mellitus, rheumatoid arthritis, tuberculosis, epilepsy, ulcerative endocarditis, nephritis, pyelitis, cystitis, salpingitis, cholecystitis, Raynaud's disease and cancer of the intestines are all the direct or indirect result of mechanical interference with body drainage. This is a fearsome list and a bold challenge! But the quality of its sponsor should curb the tongue of impetuous distrust. Men of that stamp do not idly maintain untenable opinions. They speak with conviction. The presence of a low-grade inflammatory focus near the head of the pancreas, permeated with bacteria and sodden with toxins, supplies a plausible explanation of the disturbance of that associated organ in our conception of the pathogenesis of diabetes. In view of the inadequacy of every other hypothesis, it is judicious to accord this one careful consideration. Operation has resulted favorably in this notoriously unpromising metabolic anomaly.

RHEUMATOID ARTHRITIS.—Rheumatoid arthritis, inexorable as fate in the cumulative crippling of its miserable victim, has baffled the patience and ingenuity of our ablest investigators. Etiology and therapeutics alike have been barren. Absurdity has distinguished some of the suggestions offered. This is likely to happen in conditions of great obscurity. So little light is available that any flicker is noticeable. Even Riggs' disease has had its passing vogue in this etiological relation. But now comes Lane with a causative factor big enough to fit the conditions. Instead of a few bacteria emerging from the depths of an alveolar abscess, and furnishing to the imagination an altogether insufficient explanation of such tremendous consequences, we are asked to observe a mighty incu-

bator reeking with the pestilential products of decomposing nitrogenized compounds. Here is a source worthy of respectful attention. It is obvious that here could originate any conceivable assault, no matter how deadly, upon the integrity of the organism. Our sense of proportion is satisfied, and when by brilliant surgical intervention the progress of the disease is halted and ankylosis limbers up, we are confronted with a situation summarized in the wise old aphorism about the proof of the pudding being in the eating. The startling improvement in cases of epilepsy treated with reference to intestinal incitation is a remarkable testimonial to the genius of men who have had the courage of their unusual convictions.

ULCER OF THE STOMACH AND DUODENUM.—Ulcer of the stomach and duodenum is doubtless due to the irritation resulting from angular obstruction of the latter by the downward pull of the rest of the small intestine. The stomach becomes secondarily dilated from the constant pyloric contraction maintained to resist the regurgitation of the duodenal contents. Present now are the factors favorable to the development of cancer; local irritation; local interference with circulation; the swarming microbes indigenous to decomposing tissue. Infection of the gall bladder and liver may take place through their ducts, and so-called primary cancer of the liver may be a consequence of this invasion.

The appendix may be involved in the band extending from the cecum upwards and outwards and producing a kink or some other obstruction to its lumen. The appendix may be otherwise affected by its fixation, through acquired bands, to the under surface of the ileum. The large bowel may be attached on the left side to the pelvic brim, greatly impeding the descent of fecal matter. The false membrane here may enclose the left ovary, with the ultimate result of a cystic tumor. In short, adventitious bands may appear at any point demanding additional support and may interfere in many ways with the activity of the whole tract, or may exert damaging pressure on structures in their neighborhood. The serious consequences sometimes attendant on the position of these bands have been rapidly recited. Others less menacing but nevertheless trying and objectionable extend the evil influence of this abnormality to an immense degree.

The ductless glands are coming into their own as important factors in the elucidation of many physical disorders. We have long known of the affection of the thyroid and the suprarenals. We are familiar with exophthalmic goiter and myxedema. We are as well acquainted with Addison's disease and its tell-tale bronzing of the skin, but we could not here-

tofore account for the perversion of glandular activity. We are acquiring illuminating information with regard to the attributes of the pituitary, the thymus, the testis and the ovary. We perceive that many disturbances of metabolism are connected with their derangement, but that is only a partial solution of the problem presented, for what is responsible for the derangement? Lane has succeeded in associating degeneration of the thyroid with chronic intestinal stasis and has made out a very reasonable case in the matter of the suprarenals. It is fully in accord with the best thought of modern medicine that these ductless glands should suffer from microbic incursions; and where should be the most likely breeding place but this very cesspool seething within the patient's abdomen?

FIG. 10.—CASE V. Dilated ileum proximal to Lane's band; Lane's band; ileopelvic band; angulated appendix caught in band; Jackson's membrane.

EFFECT OF STASIS ON THE INTERNAL SECRETIONS.—The study of the internal secretion is progressing with great diligence and success and we may expect to find therein the explanation of many perplexities. But hand in hand should go the inquiry into the state of the internal secretions as the *cause* of disease, dyscrasia or disorder, and as the pathological *consequences* of a previously existing infection. The last word has not been said when we cry out "internal secretions." We may show them as the cause of acromegaly and scleroderma and osteomalacia, and a growing list of obscure maladies, but only a part of the work is done; we must link them with the reason of their seemingly erratic action. Feeding pituitary extract will be incomplete and indecisive therapeusis compared with the removal of the glandular irritant. The dermatoses dependent upon or aggravated by intestinal putrefaction are many and various. It is generally conceded that any retardation of peristaltic action tends to the development of acne, eczema, urticaria, toxic erythema, erythema multiforme, bromidrosis and pruritus. The foul breath, apathy, headache and sallowness establish the identity of the suspected agency. The sweeping

out of the bowels, if complete, has a pronounced effect upon the cutaneous manifestations. But frequently the most vigorous campaign will fail to give us satisfactory evacuations, and the skin will resist our most intensive medication. Here we have to deal undoubtedly with a blocking of the intestinal lumen by mechanical obstacles. The cathartics are unable to force the straits and the stretched and straining gut retains its poisonous fecundity.

ACIDOSIS.—The interpolation of acidosis adds a word to the etiological hypothesis without detracting from its credibility. We accept the fact of acidosis just as we accept the fact of the internal secretions. It may be admitted that the skin eruptions enumerated above are fairly attributable to acidosis. It is certain that alkalies play a large part in the reputedly effective medical treatment, but acidosis is a terminal or intermediate condition, and invariably dependent on some other disturbing factor. Acidosis kills the victim of diabetes, but it does not constitute nor originate diabetes. All toxemias include an acidosis, hence the transition is easy from intestinal putrefaction to acidosis; to irritative skin diseases.

CUTANEOUS LESIONS.—There are many cutaneous lesions to which we have no etiological clue. Most of them are due to circulatory disturbances. Note the cold and waxy fingers of the "bilious" crisis. The laggard gut is responsible for them. How far a cry is it from an acute claudication to a chronic claudication and the establishment of Raynaud's disease? Circulatory anomalies underlie scleroderma. With or without the intervention of the pituitary gland, the infiltration may be ascribed to the same agency as Raynaud's disease. Of infinite variety are the germs of intestinal origin. Of infinite variety are the toxins there elaborated. How various, then, may be the manifestations in the skin or otherwise of their vicious versatility!

A normal individual gives no more heed to his intestinal canal than to respond to impulses for evacuation. There is no question of hygiene involved in such a case. The management of the bowel comes into debate only when it is manifestly unable to manage itself. We are all taught the detriment of chronic constipation. Hence, many of the results of chronic intestinal stasis are forestalled by the persistent efforts made to overcome this conspicuous symptom. This is part of the hygiene of the intestinal canal, and obviously a most important part. If the drainage from the whole tract can be effectually maintained, then, despite the narrowing at any point, constitutional disturbance will be avoided. This is the pivot on which revolves the whole discussion of intestinal stasis. If there is adequate drainage there is no stasis. If there is stasis there cannot be

adequate drainage. Adventitious bands may exist without choking the channel to a serious degree, and passage is maintained for the excrementitious tide. This is a fortunate conjunction of circumstances. If the pressure is slightly increased and the channel is a little further contracted, there will be sufficient slowing of the aforesaid tide to constitute a pathological state. There may be colicky pains and headache and perhaps vomiting; the well-known "bilious" attack. Cathartics usually prove sufficient correctives for the occasion. If sanely administered in advance, they may prevent much of the mischief.

Considerations of Diet in Intestinal Stasis.—Here is a condition where Dr. A. Everett Austin's masterly chapter on "Diet in Intestinal Stasis" will apply with peculiar aptness. The regulation of the diet along the lines of reducing bulky detritus and avoiding undue flatulence will contribute markedly to the well-being of the patient. Attacks will certainly be less frequent and more readily controlled. Apertures patulous to the passage of fluids become occluded by undigested masses such as fruit skins, lettuce leaves, nuts and slow-melting fats. Apertures competent under ordinary conditions may be occluded by the ballooning of the adjacent bowel with gas. The constriction is increased by the impediment to the venous circulation and the swelling of the tissues.

A happy termination of such a threatening episode is favored by total abstinence from food and the administration of brandy and ice as indicated for thirst and exhaustion. Situations fraught with such imminent possibilities of disaster, where sudden total obstruction may occur upon the slightest deviation from a rigid regimen, where the inclination to safety or peril is poised upon the most delicate balance, belong properly to the province of surgery. A section of drain-pipe in a house continually getting out of order through the inadequacy of its bore, would not be judiciously handled by seeing that only the thinnest fluids were allowed to enter it. The plumber would be called in and a new section substituted. So should it be with the plumbing of the human body. The intestines in addition to being organs of digestion are drain-pipes for refuse. Inadequacy of bore can be met only by enlarging the bore. Other methods of relief are temporary makeshifts trifling with the danger.

Surgery does not always mean the knife. Orthopedic surgery often operates with bloodless manipulation. As already explained, the incompetency of the canal in these intestinal conditions may be due to the sagging of prolapsed portions over new-formed bands. The raising of these portions may be followed by a straightening of the angular deformity and the enlarging of the opening. A properly fitting belt with spring support

pressing on the abdomen below the umbilicus is sometimes effectual in cases of moderate ptosis. The simultaneous administration of mineral oil lubricates the points of possible resistance and eases the jam around the corners.

In conjunction with these measures it is wise to limit the ingestion of animal foods in order to offset the likelihood of toxic absorption. On the other hand, we must be prudent in selecting alternative nutriment, as carbohydrates have a tendency to produce excessive flatulence. We are between the devil and the deep sea, and must steer our course with the greatest circumspection. Some flatulence is necessary for the propulsion of the intestinal contents; excessive flatulence defeats this object, but the decomposition of nitrogenous foods affords the elements that poison the system, whereas the decomposition of the carbohydrates results only in local distress and possible edematous obstruction.

FIG. 11.—BAND IN WHICH STUMP OF TUBE AND OVARY IS CAUGHT. (From Medical Record, Sept. 27, 1913.)

We must choose with an eye to all eventualities. There is little advantage in experimenting with lactic acid and the Bulgarian bacillus for the prevention of fermentation. There is no doubt of the tendency of these agents to act as indicated, but it is a faulty mode of procedure to seek simply to mitigate the symptoms while permitting the permanence of the ascertained and removable cause. After the removal of the cause, both these palliatives may be freely employed to assist the intestine in its readjustment to more normal conditions.

The cases of real severity threatening life by the provoking of organic diseases, rendering existence a burden by the acuity of its sufferings, baffling ambition by persistent incapacity, these incontestably belong to the surgeon and can only be aggravated by futile attempts at medical management. The young woman with the muddy complexion, the offensive breath, the thinning hair, the loss of weight, the aching head, the colicky bowels, sometimes constipated, sometimes malodorously loose, will never react to the Bulgarian bacillus or any system of dietary. She is poisoned

from the never emptied cloaca within. Until proper means are taken to drain it effectually, nothing may be looked for but an augmentation of the evil consequences. The means described as proper are the cutting of constricting bands and the reëstablishment of the patency of the drainage system.

If this proves impossible by any other course than the removal of the large intestine and the discharge of the ileal effluent directly into the pelvic colon (the procedure known as "short circuiting" the bowel), this should be done without trepidation, since it sometimes effects a miracle approaching resurrection. Patients for whom life holds no allurement, who feel that death would be surcease of suffering, whose throbbing nerves are continually at odds with their environment, who consent to exist only because "the Everlasting has fixed His canon against self-slaughter," are brought back to a world of sunshine and promise of efficiency and purpose. They have been practically snatched from the grave. They have been resurrected from a living death. This is not the rant of romance; it is the experience of the least romantic of men, the hard-headed English surgeon and his American disciples. Rhetoric cannot do the subject justice.

The man of brilliant parts whose career is threatened with premature extinction because of the increasing effort required to concentrate his attention on his work; who is becoming dull and slow and unimaginative; whose body is subject to pains and paresthesias and overmastering weariness; who has dyspepsia and neuralgia and depreciating vision; who is listless and excitable by turns; whose rest is broken, urine high colored, and bowels constipated—had better resort to an abdominal surgeon with strong convictions on chronic intestinal stasis. Hygiene any less radical than that of the knife will be of no avail. Cathartics of every description, clabbered milk, Bulgarian bacillus, bran bread, dieting, exercise, massage, will make no appreciable impression upon the progress of events. It is likely that if he has not developed cancer, or tuberculosis, or chronic nephritis, operation—the highest form of hygiene under the circumstances, since it does at once and completely what other methods slowly and haltingly attempt—operation will clear his system of the intoxication due to defective drainage. When you take the load off a spring it resumes its elasticity and power. When you rid the blood of its taint, it races to retrieve the mischief of which it was the carrier.

Some diseases of the skin create a therapeutic dilemma. We are perfectly aware of their putrefactive origin. We locate the putrefaction with admirable precision. Then we essay every mode of elimination and disinfection with which we are acquainted. We find out what the patient

likes to eat and stop it. We diet along the best approved scientific lines, and the disease persists in apparent indifference to our ministrations. What are we to do? We are progressive practitioners and anxious to give the patient the benefit of the most advanced methods. Shall we open the abdomen for acne? for eczema? for pruritus? What a tremendous disproportion between a trivial affection and a dangerous remedy! At first glance this stricture would seem entirely justified, but go a bit deeper and ask if acne is always a trivial affection? Are there no circumstances under which it rises to the dignity of a serious disease? Perhaps it never threatens life, but it does threaten the things that make life valuable; it threatens ambition, happiness and success. On the face of a sensitive woman, it is an almost unbearable disfigurement. It embarrasses, shames and tortures her; it sends her shrinking from assemblages where she might otherwise shine; it debars her often from profitable employment; it deprives her of love and marital happiness. It is a conspicuously nasty and repellent affliction.

We know the rôle played by constipation in its evolution. The acne bacillus enters little into our therapeutic calculations. We actually ignore it in striving to overcome the obstinacy of the intestine. We realize that no vaccine can wipe out the lesions if the body is not sluiced clear of its offal. If we can achieve satisfactory elimination at the anus we are far forward on the road to a favorable result. The bacillus, genuine, legitimate and trustworthy, is nevertheless incapable of fruitful insemination without the existence of a responsive soil. If the skin is defended by an uncontaminated circulation, the bacilli may rage about in ceaseless assaults, but they will never find a substantial foothold. Hence, in acne, hygiene is of more practical importance than vaccine.

DIET IN ACNE.—A properly adjusted diet, properly activated bowels, properly graduated exercise, ought to be sufficient for the successful management of the usual run of cases. If the bowels are obdurate and will not respond to vigorous urging, it behooves us to consider the likelihood of a mechanical obstacle and the existence of intestinal stasis. This confirmed, what to do? If the disadvantages of the eruption are great enough to constitute a serious menace to happiness or success, then the suggestion of operation does not violate our sense of proportion. It resolves itself into a consideration of relative values. Is a clear complexion worth to the patient the risks of laparotomy? Vanity need not be a factor in the decision. To pander to such a vice at such a price would be indefensible. But self-respect is another quality entirely and may be bound up with problems of a grave social or economic nature. If the acne is

accompanied by other symptoms of stasis, it simply adds weight to the argument in favor of surgical intervention.

TREATMENT IN ITCHING DERMATOSES.—The itching dermatoses frequently get beyond the pale of annoyance and into that of intolerable suffering and loss of health. Insomnia, anorexia, constant irritation and embarrassment furnish material for eventual nervous breakdown. If on exposed situations the eruption brings upon the sufferer the additional torment of popular suspicion and avoidance, such embarrassment is emphasized to the limit of endurance. How far may distress of this kind be borne before invoking the aid of radical hygiene, the hygiene that cleans out with one move the objectionable conditions that might resist interminably the more conservative measures? The answer lies in the comparison of the suffering with the magnitude of the remedy. Everything is relative. "Laparotomy for eczema" might sound like the irresponsible proposal of an unbalanced mind, but "laparotomy for intolerable anguish" sounds perfectly coherent and rational. Yet the two may on occasion be interchangeable expressions.

We have developed the question of intestinal hygiene from the broad standpoint of securing results in specified conditions by the most effectual means, rather than from the narrower standpoint of dieting and coaxing and coddling a recalcitrant organ. We have intimated that the use of the knife is the most hygienic procedure possible under certain circumstances. Its work is rapid, complete and permanent. It drains or cuts out the offending cesspool. It restores the relations of the various sections, or removes what cannot be improved.

If the large intestine is so out of plumb that it cannot be retained in the drainage scheme, it may be fearlessly set aside and the ileum inserted into the pelvic colon. Less sweeping measures than this are ordinarily indicated. The release of encompassed gut is the object of the operation. The least mutilation consistent with its proper performance is the rule to be adhered to. If the kinks can be straightened out by the cutting of constricting bands and the tide set fairly in the direction of the anus, the pathological situation has been relieved and all the symptoms dependent thereon should speedily disappear.

Repetition serves to inculcate more forcibly the truth of any proposition. We shall therefore venture to reiterate the sometimes forgotten fact that orthopedic surgery is bloodless on occasion, that corrective achievements are possible without the intervention of the knife; thus a case of moderate ptosis may be materially relieved by the abdominal bandage below the umbilicus and the administration of mineral oil.

The limitation of nitrogenized food will add to the security of the patient. The omission of foods with bulky residue tending to aggravate the ptosis and also to constrict barely adequate openings will contribute largely to the same end.

Hygiene of the Intestinal Canal.—The great demand to-day is not for the cure, but the prevention of disease. Scientific observation is directed to the discovery of the causes of the graver maladies with the view of eliminating them, so with regard to intestinal stasis, the greater art would be in preventing its occurrence. To do this we must hark back to infancy and regulate the intestinal hygiene along enlightened lines. The baby must be fed and not overfed. That is imperative. Most infants are gluttons who will gorge themselves far beyond their ability to assimilate. This excess must be controlled; after nursing they should not be dandled or even set upright. They must be laid down and let alone. Constipation should be combated without cessation. Flatulence and colic distend the delicate viscera and stretch the feeble attachments. Improper aliment such as "a little bit of everything off the table," and most of the baby foods on the market contribute to this occurrence. A diet on which the baby thrives with no colicky interludes and with perfect evacuations will minimize the chances of faulty structural change.

As childhood advances, sports beyond the strength of boys, and tight-fitting apparel for girls should be interdicted; especially should boys be warned against the detrimental effect of blows in the abdomen. The foolish desire for a pretty figure denied by nature and induced by art, has been the cause of many an operation for stasis. This will arouse unanimous disapproval among the devotees of fashion, but it is nevertheless the surest fact in connection with the etiology. Patients who are convalescing from prostrating illnesses are prone to the development of enteroptosis because of the weakening of the visceral supports. Obesity interlarding the viscera with inert masses of functionless fat, and coincidentally reducing the muscular tone of the abdominal and intestinal walls, creates ideal conditions for the production of stasis. Gluttony overtaxes the propulsive powers of the overloaded intestine, and ptosis is a natural consequence.

Hygiene of the intestinal canal then practically resolves itself into the prevention of chronic intestinal stasis and the removal of this abnormality after its unfortunate development. Transient disturbances may demand attention, such as the acute diarrhea from over-ripe fruit or the jamming of the rectum with undigested casein. Tubercular diarrhea may be cited as an episode in the course of a fatal disease and requires medicinal treatment. The diarrhea of typhoid fever is an incident calling for alteration

in the feeding. These are not included in the broad consideration of hygiene of the intestinal canal.

The latter has to do with conditions that will not pass away with time or with the cessation of an acute process. They are deep-rooted in the mechanism of fecal drainage. They are structural defects whose evils may be palliated in favorable cases by careful scrutiny of the nutritive intake and vigorous enforcement of a corresponding output.

Palliation exhausts the possibilities of hygiene in the usual sense. But in the wider sense of the utilization of every means for the restoration of the normal function of the part, the surgeon with his knife is as much a hygienist as the physician with his computed calories and mineral oil. The plumber who takes out a length of occluded pipe is as much an agent of sanitary science as the housewife who takes pains to prevent its occlusion. The surgeon who repairs our human plumbing is the most commanding factor in the hygiene of the intestinal canal.

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CHAPTER XV

PHYSIOLOGICAL REQUIREMENTS OF INFANT FEEDING IN HEALTH

WILLIAM C. HOLLOPETER, A.M., M.D., LL.D.

Breast Feeding: Relative Frequency of Breast Feeding; Microörganisms in Breast Milk; Colostrum; Quantity of Breast Milk; Constituents of Breast Milk; Galactagogues; Necessity for Intelligent Mothers; Nursing; Consideration of Breast Milk; Mixed Feeding; Contra-Indications to Breast Feeding.
Artificial Feeding of Infants; Certified Milk; Composition of Cow's Milk; Condensed Milk; Buttermilk; Peptonized Milk; Sterilized Milk; Pasteurized Milk; Proprietary or Patent Foods; Home Modification or Adaptation of Milk; Clinical Application of Artificial Feeding; Home Modification of Cow's Milk.
Summary of Rules to be Observed in Artificial Feeding.

BREAST FEEDING

Breast feeding has been regarded by many writers on pediatrics as a lost art. Fortunate indeed is the young mother who can supply her child with a full amount of well-balanced nutritious food. The high physical and mental tension forced upon most of us to-day calls for an evenly poised nervous mechanism, and as a result, we find many who fall below this standard. Among the well-to-do it was, until a few years ago, the exception that the young mother could acceptably nurse her child wholly for six months.

Ten to fifteen years ago, fully 75 per cent of the young mothers were unable to nurse their offspring, but now, thanks to a growing spirit of maternal pride, associated with sounder physiological knowledge and the increasing tendency towards outdoor education, this difference is passing away and to-day we see more mothers proud and willing to nurse their offspring. The young mother of to-day is better equipped physically and

mentally to nurse her offspring than was her sister of twenty years ago. This is due to the fact that she has had a better all-around education, is a better type of animal—more vigorous by reason of outdoor life—than the woman of two decades ago. Still, we have too many sentimental young mothers who will not, or can not, nurse their offspring, due probably, in part, to faulty parental training. On the other hand, it is all wrong to accuse the young mother of inability to nurse her child without careful study of existing conditions. A child may be of low vitality with sensitive digestive powers and will feel the slightest abnormality in the mother's milk. And all mothers' milk at first may lack the proper proportion of food elements due to fear of pain and general discomfort of the parturient act. In many cases, this enfeebled digestive power in the child, associated with slight abnormality in the maternal supply, is the cause of the nursing being discontinued.

Many mothers do not secrete the requisite supply of milk until two or three weeks after confinement. This variation of supply should be recognized both by the physician and mother and carefully studied before any radical changes are suggested. Frequently we have found a high fat, sugar or protein content which corrected itself within a few weeks. This condition ordinarily warrants a discontinuance of nursing of a feeble infant, while in a vigorous infant it would be a matter of small moment.

While we have just cause to rejoice in the increasing number of nursing mothers by reason of better physique and more general knowledge, due in part to the increasing number of young women who play golf, ride horseback, or play tennis, and the progressive use of the automobile, we still have too many of the nervous type—*the neurotic mother*—in spite of outdoor exercise. The neurotic mother is the stumbling block to the pediatrician's success—she makes a poor nurse, her milk constantly varies in composition, and she cannot be depended upon to produce regularly. The neurotic mother has been the means, however, of the great advance in careful feeding, even if she is responsible for so many delicate children. At the present day, the decline of neurasthenic mothers is strongly in evidence; they are less numerous, not popular, and will further decrease in the next ten years, because the great outdoors has lately become the fashion.

Relative Frequency of Breast Feeding.—The relative frequency of breast feeding varies with different countries. In Japan, all mothers nurse their offspring. Among the Eskimos, artificial feeding is unknown. At the Woman's Dispensary in Munich, an investigation revealed the fact that only 3.6 per cent of women examined nursed their offspring longer

than three months. Davis(1), studying this question in the city of Boston, in 1911, found that 68 per cent of babies between the ages of two weeks and one year were breast-fed, while in the city of New York the estimates of the Board of Health(2) record that 85 per cent of the infants in New York City are breast-fed. Koplik(3) investigated 1,007 infants in private practice in the city of New York and found only 10 per cent exclusively breast-fed, while 30 per cent were exclusively bottle-fed, 60 per cent breast- and bottle-fed, and 40 per cent were weaned before the fourth month.

Dr. Eric Pritchard(4) of London, through "mothercraft societies" first instituted at the Marylebone Street Hospital, has started an educational propaganda of enlightenment on the subject of infant feeding that is spreading throughout the British Isles and beyond like a fierce and living contagion. Since the inception of these infant consultations, or schools for mothers, the death rate has fallen from 155 per 1,000 births to 95 per 1,000, and in the city of London to 91. In Berlin(5), where infant feeding is under government control, reports show that from 1900 to 1904 only 9 per cent of infantile deaths occurred in breast-fed children.

The Health Department of the city of New York concludes from the statistics gathered by the Commissioner of Health that fully 85 per cent of the infant mortality occurred in infants artificially fed(6). In the city of Boston, in 1911, the mortality of infants over two weeks old reached 74 per cent in the artificially fed, and Davis(7) concludes that the bottle-fed is six times as likely to die as the breast-fed infant. Luling of Paris(8), in a study of 13,952 children born in Baudelocque's Clinic, reports a mortality of 14 per cent in breast-fed babies, and 31 per cent in babies who were bottle-fed by their own mothers, and 50 per cent in babies who were bottle-fed by strangers.

In the city of Liverpool, Armstrong(9) reports in a study of 1,000 infants in 1903, that of the breast-fed babies 8.4 per cent died in the first year against a mortality of 22.8 per cent among the artificially fed. The Health Department of the city of New York investigated the cause of diarrheal disorders occurring in 1908 and found that only 9.0 per cent had been previously breast-fed.

"As a twig is bent, so the tree is inclined," applies with especial emphasis to the nutrition of the young child. Success in infant feeding demands the careful observance of little details; it is not possible to feed carefully for one or more weeks and then grow careless for even a few days, for by so doing, we will either fail to gain that daily advance in development which is so essential in infancy, or possibly even precipitate

an acute illness. The young mother left to her own devices will make changes in diet not warranted by the child's condition, but largely at the suggestion of poorly informed friends.

This fact is well illustrated by the comparison of private cases with dispensary cases; fully forty per cent of the out-patient dispensary cases are below the average in weight and development, in contra-distinction to the private cases, less than ten per cent of whom fall below this average. These dispensary children are the offspring of day laborers, mechanics, waiters, and other small wage earners; they are fed correctly at times, and again incorrectly, not because of poverty, but because their mothers do not know the very important principle of regularity; neither do they understand the value of food nor the necessity for giving it at regular specified intervals. The children are not hungry; they are fed to satisfy the appetite, and not to nourish the body. To feed their children to encourage a definite purpose—the proper physical development—has never entered their minds. It is for this reason that breast feeding must be vigorously encouraged and rigidly supervised; otherwise we will soon be a race of physical defectives.

Microörganisms in Breast Milk. — The breast-fed infant receives its food direct from nature's fountain, and, because it comes direct, it is regarded as sterile. The truth is, however, that organisms from the breast gland itself get into the milk(10). Careful investigation shows that the milk of healthy women, whose breasts are free from pathologic conditions, contains microörganisms. In the majority of instances, the staphylococcus aureus is found. It is believed that the bacteria enter the breast from the outside. Milk carefully drawn is usually found sterile. This question of sterile human milk remains to be settled, but for all practical purposes we, as pediatricians, feel that breast milk is sterile. Syphilis has been induced in rabbits by inoculating them with milk from a syphilitic woman, although the woman's milk was sterile and on examination no spirochætæ pallidæ were found(11).

Typhoid bacilli were found by Lawrence in the milk of a woman suffering from typhoid fever(12). Bacteria, unless present in unusual numbers, ordinarily produce no ill effects in breast-fed children, because the germs found in human milk have no pathological significance for a healthy infant. It has been shown, however, that this is not the fact in infants with an injured digestion. Moro has recently ascribed to the staphylococci in human milk an etiologic factor in the dyspeptic conditions of breast-fed infants(13).

The taste and appearance of human milk is practically the same as

that of cow's milk. Human milk has no odor, and tastes sweeter than cow's milk; it may look paler or bluish. When cool, small white flakes cling to the side of the vessel; these disappear when the milk is warmed.

The microscopic appearance of human milk reveals it as a permanent emulsion containing many fat droplets. It also contains a few leukocytes and epithelial cells.

Colostrum.—The milk excreted during the first few days postpartum and known as colostrum, differs materially from that after lactation is fully established. Colostrum is as sweet as milk; of a deep lemon yellow tint—due to a coloring matter contained in the fat drops. The percentage of cholesterin and lecithin is greater than in milk. The fat of colostrum contains less of the volatile fatty acids than does normal milk. The specific gravity of colostrum ranges from 1.028 to 1.072, the average being about 1.040.

König gives the following analysis as an average composition of colostrum: water, 86.4; nitrogenous substances, 3.07; fat, 3.34; lactose, 5.27; salts, 0.40. We give below a table from Czerny and Keller,[1] graphically showing the composition of colostrum according to various investigators:

COMPOSITION OF COLOSTRUM

Author	Day postpartum	Fat %	Lactose %	Protein %	Nitrogen %	Ash %	Solids %
Pfeiffer.....	1	2.59	2.76	9.75	.....	0.408	.....
Pfeiffer.....	2	2.17	3.50	7.45	.....	0.340	.....
Adriance....	2	3.77	5.39	3.31	.....	0.27	12.48
Camerer and Saldner...	26–51	4.08	4.09	....	0.928	0.48	16.04
	56–61	3.92	5.48	....	0.508	0.41	14.12
Camerer and Saldner...	26–48	1.67	5.20	....	.336	.36	10.32
	48–69	2.02	5.08	....	.226	.40	10.12

Pfeiffer after repeated examinations concludes that the nitrogenous substances in human milk ordinarily range as follows: first day, 8.6 per cent; third day to tenth, 3.4 per cent; at end of second week, 2.28 per cent; in the second month, 1.84 per cent; in the seventh month, 1.52 per cent. The percentage of sugar increases in human milk while the protein decreases. The mineral content of colostrum and of breast milk after lactation is established is essentially different.

[1] Quoted by Morse and Talbot, "Diseases of Nutrition and Infant Feeding," p. 94, pub. by the Macmillan Company.

Specific gravity is usually given as 1.030-1.032. It may fall as low as 1.020 or go as high as 1.036(14).

The reaction of human milk is amphoteric. It is acid to phenolphthalein, and alkaline to litmus. The reason for the double reaction is the fact that human milk contains both mono- and diphosphates. The former are weakly acid, while the latter react as a base.

Quantity of Breast Milk.—The amount of human milk secreted by a healthy mother greatly depends on the demands of the child. The size, weight and vigor of the infant will indicate the exact amount of milk extracted from the breast in each twenty-four hours. It is natural, therefore, to conclude that a weak, immature child would not demand the same amount as a lusty, vigorous infant. What would be a normal quantity for one child would not be normal for another; therefore averages are not of any special value.

The exact amount of milk extracted at each nursing is obtained by weighing either mother or child before and after each nursing. Cramer(15) shows that multiparæ secrete a third more than primiparæ.[1]

QUANTITY IN SECRETION OF MILK BY PRIMIPARA AND MULTIPARA

Day Postpartum	Twenty-four-Hour Amount of Milk in Grams									
	1	2	3	4	5	6	7	8	9	10
Nine Babies Primipara—Wt. at Birth 3.290 grams	4	78	183	199	236	299	303	274	362	384
Seven Babies Multipara—Wt. at Birth 3.348 grams	6	129	238	324	344	324	361	365	384	415

The average daily quantity of milk secreted by healthy young mothers under normal conditions has been approximately determined as follows:

Period of Lactation	Approximate Quantity in Grams	
	Ounces	Grams
At the end of 1st week	10 to 16	300 to 500
At the end of 2nd week	13 to 18	400 to 550
During 3rd week	14 to 24	430 to 720
During 4th week	16 to 26	500 to 800
From 5th to 13th week	20 to 34	600 to 1,030
From 4th to 6th month	24 to 38	720 to 1,150
From 6th to 9th month	30 to 40	900 to 1,220

[1] Quoted by Morse and Talbot, "Diseases of Nutrition and Infant Feeding."

Czerny and Keller(16) give more details as to the amount of breast milk secreted by the average mother.[1] They show that the activity of the maternal breast may be greatly increased if the mother nurses one or more babies, as is found in a wet-nurse. They refer to a wet-nurse whose amount of milk secreted in ten days increased from 720 grams when she nursed two infants, to 1,750 grams when she nursed five infants.

AVERAGE DAILY AMOUNT OF MILK DRAWN BY A BABY
(Czerny and Keller)

Age in Weeks	Average weight of breast-fed babies given in grams	The calculated days—amt. of milk in grams	Age in Weeks	Average weight of breast-fed babies given in grams	The calculated days—amt. of milk in grams
1	3.410	291	14	5.745	870
2	3.550	549	15	5.950	878
3	3.690	590	16	6.150	893
4	3.980	652	17	6.350	902
5	4.115	687	18	6.405	911
6	4.260	736	19	6.570	928
7	4.495	785	20	6.740	947
8	4.685	804	21	6.885	956
9	4.915	815	22	7.000	958
10	5.055	800	23	7.150	970
11	5.285	808	24	7.285	980
12	5.455	828	25	7.405	990
13	5.615	852	26	7.500	1,000

Constituents of Breast Milk.—Coagulation has been more carefully studied by means of the *ultramicroscope.* The essential differences in the coagulation of human and cow's milk are as follows(17): The casein of human milk is precipitated with greater difficulty with acids or salts and it does not coagulate uniformly after the addition of rennet, while the clot that forms does not appear in such large coarse masses as the casein from cow's milk, but is more loose, feathery and flocculent.

ALBUMINOUS BODIES.—The albuminous bodies in human milk are classed under two groups: (*a*) casein, which is insoluble in water, and (*b*) lactalbumen and globulin, which are also insoluble in water. The separation of these bodies in human milk is more difficult than in cow's milk, because of the difficulty in precipitating the casein. There is on this account much opportunity for further investigations to add to our knowledge of the proteins of human milk. The figures which are most generally accepted are those of Schlossman(18), who found that about 41 per cent of the total nitrogen is in the form of casein.

[1] Quoted by Morse and Talbot, "Diseases of Nutrition and Infant Feeding."

CASEIN.—Casein is difficult to precipitate from human milk. It requires a large amount of human milk to conduct an analysis, and this has retarded our knowledge of the subject. We know more about cow's casein than human casein. As casein is insoluble in water, we must add an alkali, such as sodium citrate. On adding acid to this alkaline solution, the casein will again be precipitated.

FAT.—The fat in human milk is in a very fine emulsion. When the number of drops are counted in a counting chamber, more will always be found in human milk than in cow's milk(19). The figures as to the percentage of fat and the total amount of fat in human milk vary according to the various investigators and the methods pursued. Engel's(20) monograph on human milk gives the most complete summary of the knowledge on this subject, and is quoted freely in this article. He says the percentage of fat is smallest at the beginning of nursing and largest at the end of nursing, the steepness of the curve depending on the total amount of milk taken at a nursing. When a small amount is taken, there is a sharp rise in the percentage of fat, and when a large amount of milk is taken, there is a more gradual rise. The percentage of fat in the first milk drawn varies between 1 and 3 per cent, and that in the last milk taken between 6 and 10 per cent. These figures may occasionally be even higher. In pathological conditions the extremes of the percentage of fat are 0.1 per cent(21) and 13.7 per cent(22).

The average fat content of the milk of ten wet-nurses (German) examined by Engel was 4.5 per cent, and of 119 women (Russian) examined by Skvorlzov(23), 3 per cent. The amount of fat in the milk of the same women may vary from 25 to 100 per cent in the same day at different nursings. When the intervals of emptying the breasts are long, there is more milk and less fat. When all the milk of a woman is collected each day, the average daily percentage is constant. This is true even if the total amount of milk is considerably increased.

LACTOSE.—Milk sugar is found only in the milk of mammals. It is essentially the same in the milk of woman, the cow, ass, rabbit, dog and horse(24). There is evidence which suggests strongly that lactose is formed from the dextrose in the blood(25). The quantity of lactose varies the least of all the elements of human milk. The amount of lactose in human milk is almost twice that in cow's milk, being on the average about 7 per cent. The lowest percentage which has been found is 4.22(26), and the highest 10.9 per cent(27). A few instances have been recorded in which the addition of sugar to the diet of the mother has

increased the amount of sugar in the milk. This, however, is by no means the rule(28).

FERMENTS (ENZYMES).—Many pediatric writers place much importance on the ferments or enzymes of milk, especially in the discussions as to whether raw or boiled milk is the more digestible for infants, and in connection with the diseases of metabolism, such as scorbutus and rachitis. The study of the ferments is open to error because of the presence of bacteria in milk. It is almost impossible to obtain a truly sterile sample of milk or to keep that milk sterile for any length of time. The use of toluol or chloroform to keep the milk sterile may modify or destroy the enzymes, while sterilization by heat always destroys them. As the action of bacteria may cause all the phenomena produced by the ferments in milk, the presence of bacteria must always be excluded.

Galactagogues.—In many nursing mothers who do not secrete sufficient milk to ensure the gradual physiological growth of the child, it becomes of practical importance to know if we possess means of any value to stimulate the lacteal secretion. Hence a few words on the value of galactagogues may be instructive. Schafer and MacKenzie(29) found that the posterior lobe of the pituitary body of the ox and the corpus luteum of sheep both act as galactagogues when injected into cats and dogs. Hammond(30) found that the injection of pituitary extract into lactating goats increased the amount of milk for twenty-four hours. However, the amount secreted during the next twenty-four hours decreased below the normal, so the average of the two days was the normal amount. Gavin(31) did not find that the pituitary extract affected the quantity of milk in cows.

MacKenzie and others(32) believe that the mammary gland can be stimulated by the administration of the posterior lobe of the pituitary body, the pineal body, and the corpus luteum. The action of the former is supposed to be the most powerful. Inhibitory substances are said by some observers to be produced by the fetus, placenta, spleen, pancreas, adrenals and thyroid. Aschner and Grigori(33), on the other hand, found that the pulp of placenta or its watery extracts caused a true secretion of milk in virgin animals and that the body which causes this secretion is destroyed by alcohol and heat. Basch(34) reports that substances present in the placenta when injected into animals will bring back the secretion of milk after it has stopped.

Wolf(35) injected milk into nursing women and found that there was an increase in the amount of milk secreted. Chatin and Rendu(36) repeated Wolf's work with eight women, giving thirteen injections of milk

with the result that in eight instances the curve of milk secretion remained stationary or became slightly lowered. In the five remaining instances there was a slight increase in the amount of milk secreted after the injections of milk. This increase was, however, always in association with other factors, such as a change in the number of nursings, or a greater demand on the part of the infant. They believe that the latter was the cause of the increase and not the former(37).

There is much evidence to show that substances secreted in the ovary cause the growth of the breast gland at puberty. Cramer(38) believes that it has no influence on the hyperplasia of pregnancy, while Basch(39), on the other hand, attributes the increase in size of the breast glands to a secretion in the ovary. The blood of a pregnant animal injected into a lactating animal has no influence on the secretion of milk(40). Engel after considerable investigation concludes that there are no artificial means of increasing the secretion of milk.

Herbert Spencer has said, "The first requisite for success in life is to be a good animal"; and to be a country or nation of good animals is the first essential of national prosperity. To approach this essential or national prosperity in the right direction is the establishing of training schools for teachers and a department of dietetics and food economics in the various cities. This has been accomplished in many of our larger towns and with wonderful success. The students are taught food values, food preparation, the way to provide the most nutritious food in its most attractive form for a given sum of money.

Necessity for Intelligent Mothers.—Of the hundreds of teachers sent out from their dietetic departments of instruction every year to assume responsibility over children in all parts of the country, each and every one has learned something of dietetics and food values and will impart this knowledge and point out the great importance of correct feeding. The teachers will impress on the growing child the value of good food, without which the very best type of adult possible cannot be realized. More members of our profession should be interested in the support of dietetics and more departments of the same be firmly established in every high school for girls throughout our land. This may not seem to apply especially to maternal nursing, but I have not forgotten its application. The food and hygiene of the growing girl have the closest bearing upon her future life, and when she is called upon to perform her most important duty, motherhood, she certainly has the right and privilege to receive during her girlhood proper instructions, proper food, and normal development. This right has been too long denied the girl.

Preparedness seems to be the watchword of our nation in every department of industry, since we have been watching the holocaust in Europe, yet I fear many young struggling physicians have not fulfilled this mission as thoroughly as their opportunities would permit. The family physician has the rare chance of moulding the family tree as no other individual can; too frequently he limits his care to the ill ones alone. His function should be enlarged to include personal hygiene of the young. I feel that my work is not properly done when I neglect careful instruction as to habits and feeding of the growing child or the prospective mother. Unfortunately, it is found in almost every instance, according to my observations, that errors in child-management are due to ignorance, so I feel that it should be a part of our professional duty to take the parents into our confidence and explain why we wish certain rules and directions to be followed. In this way we avoid "bending the twig" and produce a normal mother. The ideal mother is one who is mentally normal as well as physically normal; otherwise the product will be uncertain and unbalanced.

Breast milk is variable and uncertain because the function is variable. Yet breast milk is one of the most valuable substances—it is human life, and we must know its value.

Nursing.—The nursing age is between twenty and forty; yet I have seen a girl of fifteen and a woman of fifty-five successfully nurse their offspring. I have seen the society girl succeed when the conditions all seemed to be against her; nothing is impossible to well-directed effort. Mothers vary greatly in the duration of nursing; some can nurse for two months, others five, seven or nine months. It is unusual for both mother and child to remain well after ten months of breast nursing. The best index of a nursing mother's success is her own child; if it is content and shows the usual gain, the mother has succeeded. Kerley gives the following nursing axioms:

A diet similar to what the mother was accustomed to before the advent of motherhood should be taken.

There should be one bowel evacuation daily.

From three to four hours daily should be spent in the open air, in exercise which does not fatigue.

At least eight hours out of every twenty-four should be given to sleep.

There should be absolute regularity in nursing.

There should be no worry and no excitement.

The mother should be temperate in all things.

DIET DURING LACTATION.—The diet of a nursing mother should be nearly the same as the one she has been accustomed to have, provided it

has sufficient variety and is nutritious and digestible. I have found mothers attempting to nurse their children while following a restricted diet, omitting most vegetables, for fear of creating colic in the infants; this is frequently a mistake. A robust young mother who has been accustomed to indulge in a full, generous diet cannot supply her child on a restricted diet without one or the other suffering by so doing. The withdrawal of a number of vegetables from a nursing mother's diet can be made only on account of their indigestibility, and if she could digest them before she was a mother, she should be allowed them during her nursing period.

Nursing is a perfectly normal function, and every woman, with her own child, should be influenced to carry it out along natural lines; the only thought she should magnify is that two lives are to be provided for in the place of one; therefore more food should be taken to gain this end successfully. The food in excess should be fluids, as milk in some form, soups and broths. The necessity of crowding food into the mother varies according to the age of the child. The first month, while the child is young, a restriction of all fluids may be found necessary, while in a few months it will be found expedient to feed the mother between meals. After the third month, in many cases I find the mother will take eight ounces of milk, or the same quantity of oatmeal gruel or cornmeal gruel between breakfast and dinner, the same in the mid-afternoon, and on retiring at night.

It is due to Dr. Southworth's careful study that we have come to appreciate the value of cornmeal in the form of gruel or as cornmeal mush. I have found it of considerable value and insist upon its liberal ingestion by every nursing mother when her supply of milk seems to be diminishing. The forced feeding of nursing mothers is only limited by her power of digestion, and if any article seems to disagree, it is well to discontinue the same.

BOWEL MOVEMENT.—The bowel movement is a part of the digestive function and should be most carefully watched. One free evacuation daily should be insisted upon.

The treatment of constipation in nursing mothers—a type of indigestion—is surrounded with difficulties. The dietetic method offers us little aid, because it interferes with the milk production. Usually, cooked fruit and gruels serve to keep up peristalsis. Abdominal massage is of some value. It is my request that every nursing mother receive an enema before retiring if no evacuation has occurred during the day. If the pre-

ceding methods have not succeeded, I have found the following pill valuable and I doubt that any harm has occurred to the child:

Ex. Rhamnus Pursh. ....gr. iii
Ex. Belladonna ....gr. $\frac{1}{5}$
Ex. Nux Vom....................gr. $\frac{1}{4}$

One at night; possibly another may be indicated at noon the following day, if no action has taken place. The pill is a very good tonic to the intestinal canal, a peristaltic persuader.

REGULARITY OF NURSING.—Regularity of nursing is of vital importance, for the child as well as the quality and quantity of the lacteal secretion. The breast that is emptied regularly contains a better quality as well as a larger quantity of milk.

System and regularity are as important in milk production as is digestion. If the gradual growth of the child is in keeping with the age and weight, as proved by the happy child, I begin with a bottle of water night and morning, a very necessary part of the feeding. This I continue during the first year. I have found many infants cross and unhappy because the mothers had neglected to give them water at regular intervals. Between the third and fourth month, I begin with one bottle feeding daily. This is very essential. In case of illness of the mother, or if she is called away from the child by an unexpected emergency, the child is provided for, and at the same time conditions are arranged for a very gradual change from the breast to the bottle. This can be accomplished within one year.

DURATION OF WEANING.—The average duration of weaning from breast to bottle is about three months. I am generally influenced by the health and temperament of the mother in this matter; commencing at the sixth month with two bottles daily, I add a bottle every month until the ninth or tenth month, when I have the child wholly fed by bottle. In addition to the bottle I commence at the third month to give orange juice daily. The juice of one-half of a large sweet orange is given daily throughout the year. By the time the child is six months old, I give in addition to the orange one-half ounce of beef juice daily. This I continue also throughout the year, increasing in quantity if I find it desirable.

It is usually regarded as physiological that the new-born child should lose at least one-half a pound before breast feeding is fully established. This is unnecessary if the nurse and physician are in accord in the careful management of the child. If one-half to one ounce tepid sugar water

(one per cent) be given every two hours from birth up to the time the milk supply is established, this loss does not take place. This method carefully carried out will not only guard against loss of weight, but will also anticipate the febrile state of the new-born, recognized as inanition fever.

SUCCESSFUL NURSING.—The evidences of successful nursing are many and should always be looked for. The child should be quiet, contented, and sleep most of the time. The gain in weight should not be less than four ounces per week and frequently over eight ounces per week, which is nearer the standard gain than four ounces per week. Where the gain is less than four or remains at four ounces, I suspect something wrong with the nursing, possibly irregular nursing, but more probably the fault is in the supply. An analysis of the milk will give the answer. After nursing from ten to fifteen minutes, the child should fall asleep and remain asleep until the approach of the next period, when he is again ready for feeding. Regularity enforced on the child soon establishes regularity in its demands, and the mother will soon govern herself accordingly. The stools under this carefully regulated feeding are from two to three per day, smooth, yellow, soft, and almost devoid of odor.

UNSUCCESSFUL NURSING.—Evidence of unsuccessful nursing is too frequently accounted for on the grounds of some trifling cause, such as "colds," fatigue, or defects in diet in mothers, while the real cause may be deficient lacteal secretion. When the standard established for a normal well-nursed baby falters, it must be investigated and corrected in order to maintain good results. When the maternal supply is defective, either as to quantity or quality, the child soon makes it known to the mother and physician by becoming troublesome, by crying long before the nursing period, or lingering unduly at the breast, endeavoring to extract its meal in thirty minutes that should satisfy it within half that length of time.

The most prolific cause of failure in breast feeding is naturally a scanty breast supply, and this is influenced by many factors outside of the mother herself. The nearer the supply is to the nutritional standard, the more satisfactory will be the progress of growth and development of the child. It should contain three to four per cent fat; protein one to two per cent, and sugar six to seven per cent. Failure may be due to any marked deviation of any one of the above. It has been my experience that some babies will grow irritable and lose weight while the mother is producing milk in abundance, but containing eight per cent sugar. This is not, however, the usual order of things, as most babies have a good tolerance for sugar. The same thing occurs when the fat is unduly de-

fective. In cases where we find green watery stools, the cause is most probably due to a high fat content; five or six per cent fat will always induce green watery bowel movements. In such cases, the milk should be examined; especially should this be done if the child shows effort in defecation or vomiting.

Low fat content usually brings about constipation and defective nourishment. The protein of breast milk has been regarded as the most important element to consider and the one requiring the most careful study, irregularities being sure to bring about some gastric or intestinal trouble. Increase of protein will cause colic and constipation. In such cases we will find curds, pain associated with gas, and frequently with fever, and occasionally vomiting. The mother may produce a normal amount of fat, sugar and protein, but not sufficient to satisfy the child's hunger. The child may require four or five ounces and the breast may only produce half the quantity. The only trustworthy guide in this condition is to weigh the child before and after each nursing for at least twenty-four hours. One ounce of breast milk weighs nearly one ounce avoirdupois. This method gives us the quantity but not the quality. Mistakes in quantity are frequently made by faulty weighing. The child should be most carefully weighed in the same clothing, or, better, with as little clothing as possible, to insure accuracy.

Consideration of Breast Milk.—The quality of the mother's milk is of vital moment. It should be determined at regular intervals. (This will be discussed later on.) It is interesting to observe that children gain after each meal from one ounce in weight up to eight or nine ounces, according to the age—thus a child under one week will gain from one to one and a half ounces per meal of fifteen minutes; four to eight weeks old, a gain of two to three ounces; sixteen to twenty-four weeks old, four to six ounces; and nine to twelve months of age, eight to nine ounces. This is not an absolutely fixed quantity, nor do we find many mothers producing so large a quantity at the end of the year. When a child is unhappy, unsatisfied, and no other physical reasons to be found, I generally institute a milk analysis; this is especially indicated when the weight is slowly gained or if it remains stationary. Weighing the baby once a week is the only true method of procedure. Ofttimes a child is unhappy from excess of good milk; usually it is taken too fast, when it is regurgitated or produces colic. It is more frequently tolerated for a long time.

In the presence of dilated stomach, habitual vomiting (ofttimes regarded as a healthy sign by mothers) and constipation, the child loses in weight and may be weaned from a good breast to the bottle. This unfor-

tunate result could be avoided if the physician were consulted early and proper feeding rules established.

The rule in such cases is to weigh the baby before and after feeding, and have the milk carefully examined. A nursing infant may suffer from habitual indigestion, while its mother may have unusually good breast milk; here the child can be greatly benefited by shortening the time at the breast. Weighing the baby at intervals of three to five minutes and recording the gain, reveals an intake of three to four ounces, which may represent the capacity of the child's stomach, the excess which the child obtains over this amount being the cause of the trouble. From a free full breast a vigorous nurser will take one ounce in one minute. Some infants completely fill the stomach within five minutes, and will safely hold its contents, but they must not be handled after the meal, if we wish them to retain the food; this rule is a personal equation.

When we fear the child's "speed," we must adjust the environments accordingly. Mothers must be informed that their babies cannot nurse as long as they wish, or as often as they cry. Such habits encouraged early are certain to ruin the strongest digestion later in the child's life. Frequently a mother may have sufficient quantity of milk, the child thrives, may not vomit or show any signs of indigestion, yet not continue to put on weight.

Only repeated examinations will finally show that the mother's milk lacks either fats or proteins. This may occur frequently and is best explained by finding the mother irregular in her own feeding, or personally neglectful in some other way. Strenuous personal hygiene on the mother's part may prevent the irregularity, and if the fats and proteins cannot be increased, the bottle must come to the rescue.

This failure on the mother's part leads us to mention the signs of insufficient nursing, as revealed when the child lingers long at the breast, perhaps for thirty minutes or more, and cries or shows signs of discomfort when removed. Within an hour the child cries and shows all the evidence of hunger. He will also demand frequent nursing during the night. If this condition continues, the child will not gain, but actually lose in weight. The remedy for insufficient milk must be given before the failure takes place, that is, every physical condition of the expectant mother must be carefully inquired into, examined and corrected before the baby comes, and after its arrival, every unfavorable condition must be carefully ascertained and removed. Emotional women are prone to irregularity in their milk supply, hence prospective mothers of this class should be most carefully watched.

LACK OF UNIFORMITY IN BREAST MILK.—We are frequently confronted with irregular or abnormal milk production in the nursing mother. No mother has a uniform milk; it varies from day to day, and from month to month, rich in fats and proteins at one month and less in another; these variations do not affect the child unless they are continuous and most marked. When it is found that the milk is too strong in fats and proteins, or when the ratio is not maintained, it is possible, by careful dieting, to diminish the milk strength, or, if it is found necessary, to increase the fat or protein content. The richer milk is usually found in young mothers who are athletic and robust, who eat well and whose digestion is normal. In nursing mothers of a sedentary type, a daily bath and massage, with restriction of the rich food, cutting out red meats, or, at best, allowing but a small quantity daily, and the withdrawal of all forms of wines or alcohol, will accomplish much good. The mother should be directed to walk from two to three miles daily to bring her milk to the proper digestible condition for her infant. If the dieting and walking fail to adjust the milk output, it has been my practice to order the child to have one ounce of boiled water containing a small quantity (one dram) of soda mint, immediately before each nursing. Ofttimes I find it well to give in the place of the boiled water the same quantity of barley water.

Giving barley water, boiled water or lime water—one-half ounce to one ounce—is a frequent procedure in my practice, often leading to good results. This simple dietetic advice is too frequently neglected, and should be more generally known and practiced. This easy rule has been the means of saving many lives in my hands, for it has made breast feeding possible.

DEFICIENCY IN PROTEINS AND FATS.—When the milk is deficient in fats and proteins, we must push a full diet of more concentrated food. In these cases I find Dr. Southworth's methods of feeding cornmeal mush or cornmeal gruel, to the mother, of value. This procedure is especially valuable, and readily available, when the patient is fond of corn products, which so many patients dislike, so that we fail to gain good results because the mothers do not willingly partake of the corn in any form sufficiently to gain an increase in their milk. I have seen a number of mothers, however, who have been most decidedly benefited by this addition to their dietary. In addition to the cornmeal gruel and mush, I urge the free taking of meat, fish, whole wheat bread, oatmeal, and plenty of milk in a variety of forms, junket, custard, etc., which will insure an increase of both fat and protein. The use of malt liquors in a moderate

quantity, as porter sangaree, or brown stout, will increase the fat content of a mother's milk. However, after all, we are frequently disappointed in our very best efforts to improve the quantity or quality of breast milk.

Mixed Feeding.—All breast-fed infants must be taught to take the bottle by the third month; the bottle must be familiar to the child by this time, or we will fail in our efforts. It is absolutely necessary for success later in the first year. It may contain nothing but water, yet the bottle must be given early in life. Even with the best nursing breasts, I find it necessary to commence with a bottle of modified milk by the sixth month, sometimes waiting till the seventh or eighth month.

By this time the vigor of the child demands more protein and the mother usually possesses less, so that the modified bottle is a welcomed necessity. From this time on, I increase the bottle by one per week until the tenth month, when the child is wholly weaned from the breast to the bottle. Few women can produce sufficient nourishment for a growing child after ten months, hence I find the best of mothers are willing to wean their child by this time. All children should be on the bottle from the tenth or at most the twelfth month, until they learn to chew food, that is, until they are two or three years old. Sucking is to the infant what chewing is to the adult, a necessary requisite to good digestion. I never deprive the infant of the bottle; indeed many of my children have found comfort and food in this way until they are five and even six years old.

All nursing infants, in addition to the first bottle at three months of age, can also be given one tablespoonful of orange juice per day, with or without water. At the sixth month, in addition to this orange juice, beef juice in the same quantity can be given. This is continued daily until weaning occurs. When a mother fails to give her infant two comfortable feedings per day, it is time to wean the child, and further nursing by the mother is forbidden.

Contra-Indications to Breast Feeding.—A mother must not nurse her infant when she has a fever from any cause. She cannot nurse if she shows any manifestation of active tuberculosis. Few mothers will be found entirely free from tubercular implantation, yet so long as it is not active, we cannot deprive them of this important duty. If any form of glandular or joint infection should exist, we must prevent nursing.

Syphilis and epilepsy also counterindicate maternal nursing. In advanced nephritis or any malignant growth, the breast is withheld; the same is also true in acute diseases, such as pneumonia and typhoid fever or diphtheria.

ARTIFICIAL FEEDING OF INFANTS

Inasmuch as the milk of the cow is the most convenient and cheapest, it is usually selected as the food for the infant when the mother's breast fails to sustain it. Cow's milk should not be selected, however, until every effort on the part of the mother has been exhausted. The most important consideration in the selection of cow's milk for the infant is certainly its cleanliness. This factor, fortunately, has been thoroughly impressed on the public. In the country and small towns there is no difficulty in obtaining clean milk, provided the ordinary rules of stable hygiene and cleanliness on the part of milkers and handlers of the milk are observed. The personal attention of the physician must be directed to this side of the milk problem if he is to hope for success with his young charges. In large cities the milk question becomes more difficult, as the milk has to be carried long distances, pass through several hands, and the time is much longer between the milking and the time the child receives the milk. Clean raw cow's milk is the best food (next to the mother's breast) for the child. In recent years, the superiority of clean raw milk to any other artificial food is being more fully recognized by all pediatricians, so that a most strenuous effort has been made to obtain it in all our larger cities. Through the teaching of the late Dr. Rotch of Harvard, the Walker Gordon Laboratories became the pioneer for the use of clean raw milk.

Certified Milk.—To the late Dr. Coit of New Jersey is due the perfection of methods to produce certified milk as now furnished to the public in most of the larger cities. The education of the public along these lines for a pure clean milk has resulted in the establishing of model dairy farms near all cities, so that the transporting of the milk can be effected promptly.

The rules that should prevail and must be recognized by the public are as follows:

The cows must be kept clean and healthy, especially free from tuberculosis; the stables must be clean and sanitary, free from flies; the stable yards free from manure or stagnant water; the water supply for dairy purposes should be clean and pure; the food for the cows should be free from noxious weeds or distillery slops. The cows should be cleaned by daily grooming, and the milking should be done with clean hands, from clean udders into clean pails, thus using every effort to prevent the early contamination of the milk. The first flow of milk from the udder should be discarded as unsafe. After milking, the milk should be immediately removed to a separate or adjoining building, strained and cooled, bottled and placed in a refrigerator, retained here until it is sent to the consumer. In

transporting the milk it should be kept cool and should reach the consumer with a bacterial content not above 10,000 to the c.c.

If milk can be furnished to the home in the above condition, it is perfectly safe to feed the infant in a raw state. In this way the vital principle of the milk is retained, and this is the ideal food, retaining the vitamines, of which further mention will be made.

COMPARATIVE ANALYSIS OF WOMAN'S AND COW'S MILK

Constituents	Average Woman	Average Cow
Protein	1.50	3.50
Fats	3.50	4.00
Sugar	7.00	4.50
Salts	0.20	0.75
Water	87.80	87.25

There are decided differences in mother's and cow's milk which are not apparent. Mother's milk contains ferments which stimulate digestive secretions in the infant, while those of cow's milk stimulate the digestion in the calf, not the infant.

COMPARATIVE COMPOSITION OF MILKS OF DIFFERENT ANIMALS (Voltz) (41)

Milk	Water	Solids	Fat	Casein	TotalN.	Sugar	Ash	
Human	87.58	12.42	3.74	0.80	2.01	6.37	0.3	(42)
Cow	87.80	12.20	3.40	2.70	3.40	4.70	0.7	(43)
Buffalo	82.30	17.70	7.70	....	4.80	4.40	0.8	(43)
Zebu (1 analysis)	86.13	13.87	4.80	....	3.03	5.34	0.7	(42)
Llama (3 analyses)	86.55	13.45	3.15	3.00	3.90	5.60	0.8	(42)
Camel (7 analyses)	87.60	12.40	5.38	2.98	....	3.26	0.7	(44)
Goat	86.30	13.70	4.00	3.60	4.60	4.30	0.8	(43)
Sheep	81.50	18.50	7.00	4.30	5.60	5.00	0.9	(43)
Reindeer	67.70	32.30	17.10	....	10.90	2.80	1.50	(45)
Mare	90.58	9.42	1.14	....	2.50	5.87	0.36	(43)
Donkey	90.12	9.88	1.37	0.79	1.85	5.19	0.47	(43)
Elephant	67.85	32.15	19.57	....	3.09	8.84	0.65	(46)
Hippopotamus (1 analysis)	90.43	9.57	4.51	....	....	....	....	..
Rabbit (1 analysis)	69.50	30.50	10.45	....	15.54	1.95	2.56	(42)
Guinea pig (1 analysis)	41.11	58.89	45.80	....	11.19	1.33	0.57	(42)
Dog (8 analyses)	77.00	23.00	9.26	4.15	9.72	3.11	0.91	(42)
Cat	81.64	18.36	3.33	3.11	9.53	4.91	0.59	(47)
Pig	82.37	17.63	6.44	....	6.09	4.04	0.59	(46)
Blue whale	50.47	39.53	20.00	....	12.42	5.63	1.48	(48)

Health boards of some cities, stimulated by our medical societies, now have chemists and bacteriologists whose duty it is to make frequent examinations of the milk supply as it is delivered to the consumer. These examinations are for the determination of the bacterial contents of the milk, the amount of butter-fat, the relative percentage of its various ingredients, the possible presence of chemical preservatives, or possibly any foreign matter.

When a milk dealer continues to furnish his customers with this ideal standard, he is entitled to receive labels from the board of health containing the words "Certified Milk." These labels, "certified milk," when placed on a bottle, are his guarantee to the consumer that the contained milk conforms in all respects to the standard laid down by the medical or health authorities. This "certified milk," which is sold in nearly all our cities, conforms to the following standard:

Free from pathogenic bacteria, or a bacterial content not exceeding 10,000 to the c.c.; freedom from dirt and all foreign organic matter; freedom from chemical preservatives; and, most important, a constant nutritional value with about four per cent of fat and a full average of protein and carbohydrates.

With this medical supervision of our milk supply, we have a nearly certain food for children compelled to be fed artificially. This careful precaution necessarily demands an unusual outlay of money by every city, and as a result such milk must be sold at a price to warrant the dairyman to continue his high standard. The price of "certified milk" is therefore prohibitive to the very poor of our large cities.

For this reason a second grade of milk is furnished in many of our cities by the same dairies and under the same supervision of milk inspectors known as "inspected milk," and it bears a label testifying to its relative cleanliness. "Tested milk" differs from "certified milk" only in the bacterial content. During the winter months the "tested milk" must not contain more than 60,000 bacteria to the c.c., and during the summer months not more than 100,000 to the c.c. In all other bacteriological and

CHEMICAL COMPOSITION OF COW'S MILK

Cow's Milk	Specific Gravity	Water	Casein	Albumin	Total protein	Fat	Lactose	Ash
Min.	1.026	80.32	1.79	0.25	2.07	1.67	2.11	0.55
Max.	1.037	90.32	6.29	1.44	6.40	6.47	6.12	1.21
Aver.	1.031	87.27	3.03	0.53	3.20	3.64	4.88	0.71

chemical standards, it is of the same value as "certified milk" and sells a few cents cheaper by the quart. The chemical quantitative and qualitative difference between human and cow's milk has already been emphasized. The table on page 491 from Leach shows the composition of cow's milk.

The following table shows how much the composition of the morning and evening milk may vary. These figures are the average from 29,707 tests of milk made by Droop Richmond in England:

VARYING COMPOSITION OF MORNING AND EVENING MILKS

Milking	Fat per cent	Lactose per cent	Protein per cent	Ash per cent	Solids per cent
Morning......	3.44	4.71	3.43	0.74	12.34
Evening......	3.90	4.69	3.39	0.73	12.71

Composition of Cow's Milk.—Cow's milk is never uniform in its composition. It differs even in the same cow morning and night, winter and summer. (*See* table.) The composition of the milk of a single cow may differ considerably from that of an entire herd. It is for this reason that the milk of a herd of cows is to be preferred for general purposes to that of a single cow. However, when it comes to the recognition of tubercular infection, we can detect it in one diseased cow much sooner than in a herd. The composition of milk varies in different types of cows, some cows being better providers for human infants than others; but all cows have milk for calves, not for children. The Guernsey and Jersey cows furnish a milk richer in fat, frequently over five per cent. The Holstein breed furnishes a less perfect emulsion of fat. The Durham and Devon cows yield a good rich milk, and when properly cared for provide good safe food for the young infant.

Cow's milk is an opaque emulsion of fat in solution. The vehicle is albuminous, containing lactose and mineral matter. The color is yellowish white. The odor is not strikingly characteristic, unless the cow has been feeding on rank weeds or garlic, or is suffering from disease. The specific gravity at 60° F. varies from 1,029 to 1,034, the difference depending on the composition of the milk. The reaction is amphoteric when the milk is strictly fresh. It becomes acid by exposure and the multiplication of the lactic acid bacillus, and the acidity increases with age. The addition of preservatives increases the alkalinity.

FAT.—The fat of cow's milk contains stearin, olein and palmitin, which are volatile and readily decomposed. When milk stands for a short time, the fat, being the lighter, comes to the surface and is known as cream. The fact that about four per cent of fat is found in human and cow's milk requires us to analyze the two forms of fat more closely. Cow's milk contains a greater percentage of volatile fatty acids, and a less percentage of oleic acid than human milk, and the fat in the former is in a coarser emulsion and separates more easily than in human milk. The difference in the composition of the fats of the two milks may, in part, explain the fact that the human infant can digest and assimilate four per cent of fat in woman's milk, and yet fail to digest two per cent of fat in cow's milk, and it may also explain why cow's milk, with its excess of volatile fatty acids, may predispose to acid intoxications in infancy, since these acids are readily converted by hydrolysis into acetic acid and acetone.

PROTEINS.—The chief proteins of milk are casein and lactalbumen; lactoglobulin, lacto-protein and nuclein occur in smaller quantities. Whey protein contains all the proteins of milk, except the casein. In woman's milk, the whey protein exceeds the casein in the proportion of two to one, but in cow's milk the proportion is as one to six. Chemistry has not as yet established any difference between the whey proteins of cow's milk and woman's milk, but these two milks are entirely different in the quantities of casein and soluble albumins they contain. The difference most important to the clinician is the chemistry of the two caseins. This difference is practical and concerns the manner of their reaction to the same ferments and reagents.

In the stomach of the human infant, the calcium casein of cow's milk (the form in which casein exists in cow's milk) is readily precipitated by rennet, in the presence of a slight amount of acid, into a clot of calcium paracasein, and later, as the hydrochloric acid is secreted in larger quantities, into hydrochlorate of paracasein and calcium, the calcium being separated from the paracasein clot by the hydrochloric acid. This clot is larger and tougher than the clots which occur in the infant's stomach from the action of the same reagent on human milk.

In human milk the paracasein clots and the hydrochlorate of paracasein clots are softer and lighter—more flocculent, as compared with those of cow's milk. In artificial feeding, casein is most frequently blamed for disturbing the child's digestion. To increase or diminish the percentage of casein content in the bottle of an infant was supposed to alter the digestive injury. This practice has been discovered a grievous mistake, as the casein is very rarely the cause of intestinal trouble.

The most frequent types of food injury are due to the sugar or fat content.

Finkelstein and Meyer have demonstrated that intestinal indigestion may be improved, if not controlled, by increasing the casein content and diminishing the fat and sugar in the milk. The digestibility of the casein of cow's milk depends largely on the presence or absence of the condition of the child's stomach which causes its precipitation in small or large clots. Casein is very easily digested and assimilated if large clot formation can be prevented.

If an alkali be added to the cow's milk before it enters the stomach, such as sodium citrate, sodium bicarbonate, or even lime water, large clot formations may be avoided. Hydrochloric acid or lactic acid will also accomplish the same result. The alkali or the acid combines with the casein and breaks up large clot formations. This it does by interfering with the action of the rennet; rennet can only act in the presence of a slightly acid medium.

The value of boiling milk, as is frequently necessary during hot weather, is clearly seen by this formation of small clots; hence its double value by killing bacteria and rendering the milk more digestible. It may be necessary to reduce the fat in the milk temporarily, so as to prevent its entanglement in the meshes of the clot. The danger, therefore, in the high percentage of casein feeding is that we may not be able to control the cause of clot formation.

The human infant may digest the various food elements of cow's milk when they are held in the whey of human milk and may fail to digest them in the whey of cow's milk. Any food for the young infant that does not maintain the usual casein content is absolutely wrong. The casein of cow's milk contains 53 per cent of carbon, 16.65 per cent nitrogen, 7.08 per cent of hydrogen, and 0.85 per cent of phosphorus. This composition of proteins with the large per cent of nitrogen content makes them actually necessary for all growth and all life.

CARBOHYDRATES.—The carbohydrate content in cow's milk is 4 per cent; in human milk it is 7 per cent. Lactose is the only carbohydrate found in milk. The variation in quantity of this sugar from day to day and with the age of the infant is surprisingly small. Fats and proteins vary from day to day and according to the condition of the mother, but the sugar scarcely changes. Milk sugar in human milk is especially adjusted to supply carbohydrate food to the young infant. It does not easily ferment and is quickly converted into dextrose in the intestines. German pediatricians, however, regard milk sugar as the most common cause of

intestinal fermentation. It seems that milk sugar when held in the whey of cow's milk is less rapidly absorbed and more frequently augments fermentation than maltose or dextrin. The majority of normal infants can readily digest sugar.

Sugar next to albumins is the most important food of the infant. Like the fats, sugar serves as a fuel for the production of heat, and supplies the food which furnishes energy to the growing cells. In their heat-forming capacity, carbohydrates are second to the fats, but in their energy power they are most important. It is an interesting physiological fact that the oxygen contained in the carbohydrates is not only sufficient to oxidize their own hydrogen, but to aid materially in oxidizing the waste products of the fat and protein molecules as they are broken down in the body, thus preventing an auto-intoxication. This is a beautiful fact pressed home on us all as an illustration of the interdependence of the protein, fat and carbohydrate molecules in serving the nutritional demands of the body, and makes very plain the truth that we act wisely and according to nature's lead when we imitate nature in making an infant food by combining these food elements in proper proportions.

Clinically the physician soon expects trouble when the food elements are not kept in their natural proportion; thus an excess of carbohydrates, with other food elements, especially the fats, in normal proportions, may result in diarrhea, loss of weight, fever, and generally a catarrh of the digestive tube. An excess of carbohydrates with other food elements below the normal may result in anemia, rickets and malnutrition. A severe food injury may arise by overtaxing the digestive capacity when we have a deficiency in carbohydrates with the other food elements in excess.

INORGANIC CONTENTS.—The ordinary inorganic constituents of milk are calcium, sodium, potassium, magnesium, phosphorus and iron. All of the above, except iron, are present in both human and cow's milk in sufficient quantities to meet the nutritional demands of the growing infant. The hemoglobin contains iron as a very necessary constituent to the oxidation process which underlies body metabolism. The deficiency of iron in milk, which gradually increases as lactation proceeds, is made up in the first year of life from the iron found in the liver and other organs of the new-born infant. It is found that at birth there exists as much iron in proportion to body weight as in adults. The partial iron starvation which necessarily occurs on a milk diet is not, therefore, of material consequence during the first year of life. As the child grows older, the storehouse of iron becomes exhausted and it is necessary to supplement the milk diet by such iron-containing foods as fruit juices,

eggs, purées of vegetables and broths; otherwise anemia and malnutrition may result.

It is true that the other inorganic constituents play a no less important rôle than iron in the body metabolism of the human infant. All those I have mentioned are found in such organic combination in human milk as to be readily assimilated in sufficient quantities to meet nutritional demands. A healthy infant can usually assimilate a sufficient quantity of the inorganic constituents of cow's milk. The fact that a smaller quantity by percentage of the salts of cow's milk is assimilated is offset by the fact that they occur in larger quantities in cow's milk than in human milk.

In certain pathological conditions, however, the failure of the human infant to assimilate the salts of cow's milk produces serious disorders of nutrition and frequently becomes a factor in the production of wasting or atrophy. The frequent practice of adding lime water, sodium bicarb. or sodium chlorid, or better, sodium citrate to cow's milk, not only promotes the digestion and absorption of casein, but also facilitates the absorption of the mineral salts of the milk, this being especially true of calcium. The following table is taken from various sources:

PERCENTAGE OF SALTS IN COW'S MILK IN 100 PARTS OF ASH

	Bunge (49)	Abderhalden (50)	Schloss (50)	Soldner (51)	Pelka (49)	Richmond (52)
K_2O	22.14	22.40	24.74	24.96	23.75	28.71
Na_2O	13.91	12.25	10.79	6.16	15.36	6.67
CaO	20.05	21.07	21.35	22.25	20.37	20.27
MgO	2.63	2.91	2.71	2.71	.....	2.80
Fe_2O_3	0.04	.....	.....	.....	.....	.40
P_2O_5	24.75	24.10	29.54	32.27	27.13	29.33
(CL)	21.27	17.25	13.63	10.86	14.67	14.00

One Liter of cow's milk contains in grams:

	Soldner (51)	Schloss (50)
K_2O	1.72–1.885	1.849
Na_2O	0.51–0.465	0.861
CaO	1.98–1.72	1.650
MgO	0.20–0.205	0.215
P_2O_5	1.82–2.437	2.183
CL	0.98–0.82	1.091

100 grams of the Ash of Cream contains in grams (53):

K_2O	25.97
Na_2O	9.86
CaO	20.54
MgO	4.20
P_2O_5	30.23
CL	16.15

It would be trifling for me to point out the value of mineral salts to the infant body; they are very essential for the proper balance, growth and functional activity of all its cellular elements. They enter very largely in the construction of the bony framework of the infant's growing body, and for symmetrical development larger quantities are required. They also maintain normal irritability of nerve and muscle elements; a lack of calcium or phosphorus in the growing infant will produce abnormalities in the bony framework and will greatly exaggerate the irritability of nerve and muscle.

The mineral salts and their combinations are a very essential part of the infant's food. They must be present in proper relative proportion, but also in such a form that they can be easily absorbed and appropriated. This absorption of mineral salts so essential to the proper growth of the young infant can only be accomplished during the first few months of life by the administration of milk as a medium which holds the nicely adjusted balance. Human milk is the ideal food for this purpose, and next to that is some adaptation of cow's milk to meet the same requirements. Water is an important constituent of the food of an infant. About 68 per cent of the infant's body is composed of water, and about 87 per cent of its natural food—milk—is water.

This indicates the great importance water has in the physiological process necessary to maintain the health and life of the infant. An infant requires four or five times as much water in proportion to body weight as an adult. Water is the great solvent which brings into solution the food of the infant so as to present that food in such a form that it can be readily cared for by the digestive organs. It carries the digested food through the blood and lymph channels to every part of the body. This common carrier makes up about 78 per cent of the blood and 96 per cent of the lymph, and becomes the circulating medium of the body, carrying the important elements of the blood and lymph to every cell in the body and carrying away from the cells, to be excreted, the waste materials of retrograde tissue metamorphosis. This excretion of body waste prevents autointoxication and is effected by the elimination of the water carrying this waste through the kidneys, the intestines, the skin, and the lungs. This elimination is much more active during infancy, hence the supply must be constantly renewed.

DIASTATIC FERMENT.—It is believed by many physiologists that there exists a diastatic ferment in human milk which transforms starch into maltose and dextrose. It has been demonstrated by a number of observers that it can be developed in cow's milk and goat's milk by feeding them on

germinating barley. This would indicate that this ferment serves an important physiological purpose in the human infant, which is met in some other way in the young of the cow and the goat. The purpose served is perhaps to supplement the feeble digestive power for starch in the young human infant, and as the starch digestive capacity of the young of the cow and the goat is greater, it is not necessary to provide this ferment in their milk.

VITAMINES IN COW'S MILK.—Long before we read of Casimir Funk(54) and his studies, we knew that whole clean milk is next to the mother's breast the very best food for the growing infant. We knew that the child is better nourished and happier on whole clean milk, that digestion is easier and development more regular than when the child receives boiled or sterilized milk. We knew whole milk is milk with the life in it, not boiled milk with the life boiled out of it. Funk tells us that vitamines or certain vital "accessory substances" exist in whole milk that serve to protect the child from deficiency diseases, such as beriberi, scorbutus, pellagra, and rickets. He thinks these diseases are due to the absence of certain vital substances in the milk which he calls "vitamines." He shows in his article that milk contains a considerable number of these antiscorbutic substances as well as substances which materially favor the growth of young infants. The vitamines are, in general, very sensitive to heat. Those in milk are relatively stable. They are, however, partially destroyed by heating milk for a short time, and totally destroyed by long boiling as in sterilization.

The development of scurvy in babies taking heated milk and the greater frequency of the disease when the food is boiled or sterilized than when it is pasteurized, may be explained by assuming that the vitamines are partially or wholly destroyed by heat, the destruction being more or less complete according to the degree and duration of the heating. It is true scurvy sometimes develops in babies taking raw milk or even in babies fed at the breast. This explanation of the development of scurvy on a diet of raw milk is that in such instances the milk is deficient in vitamines.

In support of this explanation he brings forward evidence to show that the amount of vitamines in the milk varies with the amount of vitamines in the food of the cows. An example of the influence of the food of the cows upon the amount of vitamines in the milk, is the fact that their milk contains less vitamines in the winter, when they are eating dry food, than in the summer, when they are eating green food. The development of scurvy in infants at the breast may be explained in a similar way. He

calls attention to the fact, moreover, that the vitamines are diminished in the milk of women who are underfed.

Many objections can be raised to Funk's arguments, and it may be urged that his premises are incorrect and his conclusions consequently not justified. Still, his proposition that scurvy is caused by the diminution or absence of certain essential vital elements, or vitamines in the food, reconciles and explains the clinical facts and experimental evidence as to the etiology of this disease better than any other which has been advanced.

Condensed Milk.—This type of milk is frequently used as food for young children during an emergency, as in traveling or before the breast milk has been fully established. It is prepared by evaporating cow's milk about one-fourth in volume and adding cane sugar as a preservative; this is added—five to six ounces of sugar to the pint. The composition of condensed milk is shown by Holt in the following table:

TABLE SHOWING COMPOSITION OF CONDENSED MILK

	Condensed Milk[1]	With 6 parts of Water Added	With 12 parts of Water	With 18 parts of Water
	per cent	per cent	per cent	per cent
Fat	6.94	0.99	0.53	0.36
Proteins	8.43	1.20	0.65	0.44
Sugar {Cane, 40.44; Milk, 10.25}	50.69	7.23	3.90	2.67
Salts	1.39	0.17	0.10	0.07
Water	31.30	90.49	94.82	96.46

[1] Analysis of Borden's Eagle Brand of Condensed Milk made by E. E. Smith, Ph.D., M.D.

An examination of the percentages given in this table shows that condensed milk is not a proper food for young or older infants, inasmuch as it does not contain the proper balance of food contents, fats, protein and sugar. It is deficient in fats and proteins and too rich in sugar. Infants fed on condensed milk must sooner or later suffer from some form of nutritional disturbance. Condensed milk is a very dangerous food if long continued, as it is prone to give parents a false sense of security; it makes fat babies, but they are flabby and anemic. Infants fed on condensed milk have weak powers of resistance, they are likely to chill easily, suffer from bronchitis, and drift into rickets. We consider the early and prolonged use of condensed milk as the most prolific means of adenoid

formation by devitalizing the mucous membrane of the nasopharynx. As a proof of this, the teeth are generally defective and erupt late and slowly, the bony skeleton is more slowly and generally imperfectly developed. Although condensed milk long continued almost invariably produces more or less serious malnutrition in some form, it is a very valuable temporary food for infants under certain conditions. Its advantages are quickly recognized by the poor mother in crowded hot cities. It is cheap, easily digested, sterile, easily prepared, and easily manipulated. It appeals, therefore, to the poor who cannot afford to buy clean cow's milk.

Thousands of infants in our larger cities are carried through the summer months on condensed milk, who would have died from some gastro-enteric trouble if their mothers had been compelled to feed them upon such cow's milk as they could procure, and these rachitic malnourished infants, who have passed through the crisis of their existence on condensed milk, may with the approach of the cooler weather, gradually overcome this malnutrition by the addition of more wholesome food to their diet. The difficulty of changing the diet of an infant kept on condensed milk to properly adapted cow's milk is found in the fact that the infant's digestive tube has not been properly unfolded, or more properly speaking, developed, and the substitution of cow's milk involves the danger of adding gastro-intestinal injury to malnutrition. Great care is necessary on the physician's part in adding very gradually the correctly adapted cow's milk to the condensed milk feedings.

Buttermilk.—Buttermilk has been used as an infant food for many years. It had its origin in Holland, where many of the leading physicians depend on it and obtain remarkable results. It deserves more attention in America than it has received. In recent years, the experience of able physicians the country over has demonstrated that it may become a valuable substitute for cow's milk in infants suffering from various forms of gastro-intestinal troubles. The buttermilk used in infant feeding is usually made from cream or milk that has soured naturally. The souring process in the milk, however, may be started by inoculation with sour milk, or with lactic acid bacilli from a culture. The last is not usual for the physician.

Unfortunately, the composition of buttermilk is so variable that results are uncertain. The average, however, contains about one per cent of fat, four per cent sugar, and three per cent of proteins. It, therefore, should have a food value of about 400 calories to the quart. Physicians differ somewhat in their methods in its preparation for infant feeding. It is usually prepared as follows: to one quart of buttermilk are added two

level tablespoonfuls of wheat flour and one level tablespoonful of cane sugar. This mixture is, with constant vigorous stirring, slowly brought to the boiling point and kept there for twenty minutes, and then allowed to cool. The constant stirring prevents the coagulation of casein.

Buttermilk prepared in this way has the same percentage of fat and protein as above given, but the carbohydrates have been increased to ten per cent, and the food value of the mixture has been increased to 600 calories per quart. This buttermilk mixture, when considered from the standpoint of infants, contains a low percentage of fats and a comparatively high percentage of proteins and a very high percentage of carbohydrates. The casein is very finely divided, separated from its calcium base, and appears in the form of the lactate of casein which cannot be acted upon by rennet, but which is readily digested by the intestinal ferments. The acidity varies in the neighborhood of 0.5 per cent.

The chief value of buttermilk, therefore, is the larger quantity of easily digested casein which it contains, the small amount of fat, and the large quantity of easily digested carbohydrates, which substitute the fat in serving the nutritional demands of the body.

Buttermilk, notwithstanding the fact that it may be used in the feeding of well infants for some months at a time without apparently producing nutritional disturbances, is an ill-balanced food mixture, not capable of satisfying the full nutritional demands of the rapidly growing infant. It can only be used, therefore, as a food for normal infants when properly modified cow's milk cannot be obtained.

The ideal field of usefulness for buttermilk is found in that class of infants deprived of the maternal breast in whom the improper adaptation of cow's milk has produced some form of food injury, a gastro-intestinal disturbance, and who are, therefore, temporarily, unable to digest cow's milk. I have used it in beginning atrophy and acute gastro-intestinal indigestion. It goes without saying that this buttermilk formula may be so modified by the addition of sterile water as to suit the age and digestive capacity of the infant.

Peptonized Milk.—In the artificial feeding of premature or malnourished infants, the milk used (cow's milk) may be partially or wholly peptonized. In the management of this class of infants there frequently arises a period where wholly peptonized milk is necessary. This period, however, must not be prolonged or we fail in developing the infant's digestive capacity. The moment we find the infant is gaining daily it is our duty to lessen the length of time the milk is peptonized. With this fact firmly in our minds, we may use with great advantage partially or

wholly peptonized milk in feeble or immature infants until we gain control of the digestive tube, for by so doing we not only save the child from atrophy, but we may also prevent its drifting into rickets. The rule, therefore, in using a peptonized milk formula is to administer it until the infant's stomach has regained sufficient power to assimilate the proper cow's milk adaptation. The infant's stomach not only requires proper food, but it also requires the chance to digest milk, which is its proper function. If we fail to unfold the digestive function by withholding proper food, we seriously handicap the infant's progress. Peptonizing tubes are on the market rendering the procedure very convenient for the physician and the mother, one tube containing enough for a pint of milk —usually associated with a little bicarbonate of soda to prevent coagulation.

The milk is peptonized at a temperature of 110°F. for ten to fifteen minutes, when it is immediately placed on ice to arrest the further peptonization. Care must be exercised not to push the process too far or the milk will acquire a bitter taste and the child will refuse to take it. Cane sugar can be added if necessary to overcome the bitter taste. I have found in my work that keeping the milk at a temperature of 110°F. for six to ten minutes is usually sufficient. This is a decided advantage for the infant in many ways and is much better when we commence to withdraw the peptonized milk.

Sterilized Milk.—Sterilized milk is still used by a very large proportion of the city's poor. With all the combined efforts of health boards and medical societies it has been found impossible to furnish clean whole milk at a price within the reach of the poor. The "certified" and "inspected" milk, owing to its prohibitive price, can be utilized in the feeding of only a comparatively small percentage of the infant population of our larger cities. For this reason, sterilization and pasteurization of milk still remain most important life-saving measures in the feeding of infants during the summer months; it is the only reasonable method, when, by reason of the heat, milk contamination increases rapidly. It is well for us to remember that we cannot sterilize unclean milk, milk containing large numbers of micro-organisms, without impairment of its nutritive value. Milk which has undergone fermentative changes and which may produce poisonous irritating bodies, is a dangerous food for infants. Milk thus exposed and contaminated cannot be made wholesome by sterilization. If we wish to sterilize as a means of preventing bacterial contamination, it is necessary to start with the cleanest milk that is obtainable.

Cow's milk is sterilized by heating to 212° F. for twenty minutes. This is what is usually known as sterilized milk; the heat destroys the vitamines and all the developed bacteria, but does not destroy the spores; thus the milk is not actually sterile, for the spores after a time develop into bacteria. The sporulated bacteria are not of sufficient importance to justify the additional application of heat. Sterilization of milk is best accomplished by placing the milk bottles in boiling water for twenty minutes, boiling hard and filling the tops with sterile cotton and then placing on ice for use. The Arnold Stearns Sterilizer is a convenience and of great practical value for the poor of large cities. It is cheap and its simplicity is apparent to all.

ADVANTAGES OF STERILIZED MILK.—The advantages derived from sterilized milk must be mentioned. There is a loss of acidity on the part of the milk which causes a retardation in the rennin coagulation and thereby causes the casein to be precipitated in finer flakes, so that it is more readily acted upon by digestive ferments; large casein curds never form in sterilized milk. The fermentative processes are stopped and the milk is not further contaminated by bacteria. This is the important object of the work and greatly reduces the dangers of milk poisoning. Sterilization is a cheap method of preserving milk and is practically the only way for the poor to keep milk wholesome for their children. The poor can neither keep nor handle clean raw milk; they cannot afford to do so, even if they knew how. Sterilized milk is better than the patent foods or condensed milk for the very poor. If the infant is capable of digesting sterilized milk, this serves nutritional purposes much better than the proprietary foods.

DISADVANTAGES OF STERILIZED MILK.—The disadvantages of sterilized milk, unfortunately, are many. The decomposition of nuclein, a separation of the phosphorus from its organic union; partial destruction of the fat emulsion; increased difficulty in the digestion of casein; partial separation of the lime salts from the combination with calcium, which renders them less easily absorbed; complete destruction of ferments, alexins, agglutinins and other vital principles in the milk. The loss of vital principle (vitamines) is the most important. The radical change in the milk, converting a living vital element into a dead product means a great nutritional loss to the infant. Sterilized milk being hard to digest constipates the infant, who as a result frequently faces intestinal intoxication with all its constitutional depreciation.

Pasteurized Milk.—Physicians actively engaged in infant feeding soon realized the defects of sterilized milk and began to try milk treated at a

lower temperature. This was done with the hope of destroying the bacteria without producing important chemical and biological changes in the milk. Koplik first suggested heating the milk and Monti recommended a temperature of 180°F.; Freeman has insisted on a still lower temperature and his apparatus has done much to popularize the method. This process aims at killing the greater part of the developed bacteria without producing serious chemical or biological changes in the milk. The procedure is called pasteurization to distinguish it from sterilization. Pasteurized milk is very generally used in this country, especially in our larger cities during the summer months, and when properly used becomes a most important means of saving young infants.

Freeman's conclusions on the subject are as follows: "Milk for infant feeding should be pasteurized so as not to interfere with its biological properties or chemical composition, but at a sufficient temperature to destroy the bulk of the bacteria present, including the tubercle bacilli. A temperature of 140°F. continued for forty minutes would seem to fulfil these indications." Freeman also says the question concerning the effect of heat on ferments has been carefully worked out by Hippins. The salol-splitting ferment found only in mother's milk was weakened by a temperature of 131°F. and destroyed at 149°F., while the amylolytic ferment found only in mother's milk was weakened by a temperature of 158°F. and destroyed at 167°F.

It seems evident, therefore, that the careful pasteurization of milk may serve the purpose of checking the fermentation process without materially changing its chemical composition or biological properties. Clinical experience strengthens this opinion, for milk pasteurized at low temperature may be fed for a long time with practically the same results as are obtained from fresh clean raw milk. The preparation of pasteurized milk, however, requires time, care and intelligence; moreover, a subsequent refrigerator temperature is necessary in order to prevent bacterial contamination. The method is, therefore, not commonly available for use among the poor of our large cities. It has, however, a large field of usefulness among those city dwellers who have the time and intelligence to prepare pasteurized milk and the facilities to care for it after its preparation, as in our large cities even the best available milk is rendered safer during the hot summer months by pasteurization.

Proprietary or Patent Foods.—The market is full of convenient foods to feed the baby when the maternal breast fails to furnish the natural supply. These foods are attractively placed before the public and are convenient to use, hence young mothers are readily induced to resort to

them without proper regard to their real value. All these foods possess some nutritive properties, and may prove useful in an emergency. It is well, however, to remember that infant foods, to be of any value, must possess fats, sugar and protein in certain definite proportions, associated with mineral matters. Any proprietary food that does not contain the above elements in proper proportions can do but little good. The elements of infant food are easily procured and can be obtained in modified milk. We do not understand why so many young mothers under the close observance of their physician are allowed to resort to many of the proprietary foods. Inasmuch as they all possess some value while lacking some of the essential elements, it is not desirable to encourage their use, unless it is to bridge over a passing difficulty. A very brief outline of a few of these foods seems desirable.

NESTLE'S FOOD.—Nestlé's Food is one of the most convenient and easily digested of the proprietary foods. It is found to be a convenient and valuable substitute for cow's milk in infants suffering from gastro-intestinal troubles, especially during the hot weather, yet if long continued, it is disastrous in its results. Its indefinite employment will most certainly produce rickets or scorbutus. Chittenden's analysis of Nestlé's Food prepared for infants of six months, shows that this food prepared for this age contains only 0.81 per cent of albuminoids and 0.36 per cent fat. This marked deficiency in fat and protein renders it quite unfit to serve the nutritional demands of the infant for any length of time.

When it is found necessary to use Nestlé's Food it should only be allowed until acute symptoms have been controlled, after which small quantities of cow's milk should be added, and as the child continues to convalesce, additions of milk should be gradually made and Nestlé's Food mixture likewise diminished, until a modified milk formula replaces the proprietary food. If, however, it be found necessary for some time to continue Nestlé's Food, or any other patent food, by reason of digestive weakness, the infant should be given supplemental foods in form of orange juice, pineapple juice, or that which is more valuable, beef juice. This addition to a weak infant's diet very frequently prevents scorbutus or rickets which frequently follow in the wake of ill-balanced feeding.

MALTED MILK.—Malted milk is a proprietary milk food which, like condensed milk and all the proprietary foods, is very poor in fat and protein. It is unsuitable as an exclusive food for infants. It is safe, however, for a brief period as a substitute for milk in traveling or when, for any other reason, cow's milk is not obtainable. It is, like condensed milk, very extensively used among the poor of our cities, because it is

easily digested, easily prepared, and serves the purpose of tiding the infant over the hot summer months.

Home Modifications or Adaptation of Milk.—This is seemingly a most difficult topic to adjust in many physicians' minds, and the study of the subject must be based upon the elements of nutrition themselves. A few essentials from Cheadle, written nearly thirty years ago, may be of value in crystallizing in our minds the principles of cow's milk feeding as outlined in the preceding pages.

(a) *The food must contain the different elements in about the same proportions as found in human milk,* viz., proteins, one to two per cent; fats, three to four per cent; carbohydrates, six to seven per cent; salts, two-tenths per cent; water, eighty-eight per cent. This represents theoretically the ideal food for a balanced nutrition. The chemist can readily produce a mixture which duplicates breast milk in the nutritive value of its constituents and even resembles somewhat closely that emulsion in its physical appearance, but the dismal array of failures to reproduce mother's milk by a synthetic arrangement of apparently similar constituents obtained from other sources, is an emphatic reminder of the limitations of both chemical and physiological knowledge.

(b) *It should not be purely vegetable, but must contain a large proportion of animal matter.* Most vegetable substances are deficient in available proteins and yield but a small quantity of fat. Moreover, it is known that the infant does not assimilate them as easily and fully as those derived from animal sources, even though these ingredients be supplied in the proper percentage.

(c) *It must be in a form suitable to infantile digestion.* The digestive organs have only recently assumed their function, and are designed to deal solely with the bland, dilute, and easily dissolved nutriment of mother's milk. In the natural method of feeding the infant gets his nourishment in the same form at every meal; so in artificial feeding, variety is not desirable. It is presumed that infants under six months are unable to digest much starch from the paucity of ptyalin and amylopsin; hence, for this age any great amount of starch in a food is enough to condemn it. As the walls of the stomach are lacking in muscular power and the secretions are feeble, it is evident that this organ is unable to deal with large masses of solid matter. Solids can be digested only in a state of minute subdivision.

(d) *The total quantity in twenty-four hours must represent the equivalent, in nutritive value, of from one to three pints of human milk, according to the infant's age.* No fixed rule can be given for all children.

Careful observation of the infant as to whether he rejects some of his food soon after ingestion, or seems hungry half an hour after feeding, may serve as a guide. The best indication that he is receiving his full equivalent is a steady weekly gain of from two to five ounces—or more in the early months.

(e) *It must possess the antiscorbutic property.* It is not yet known in what this consists, but it is known that infants at the breast very rarely suffer from scurvy, and that the disease is found among those fed upon condensed or sterilized milk, or upon desiccated milk preparations. Prompt recovery, with food unchanged (except the discontinuance of sterilization), has been reported by several observers. Fresh milk, therefore, possesses, in addition to the important principles, this antiscorbutic element (vitamines), but not in large proportion, for milk in extreme dilution will not prevent the development of this disease.

(f) *It must be fresh, clean and free from excessive bacterial content.* It is true that hydrochloric acid has antiseptic properties, but the stomach secretes only a limited quantity of it during the first half year. Hence, infants are extremely susceptible to gastro-enteric disorders, having little resistance to bacterial invasion. The deadly toxins which develop in old milk may resist all efforts at sterilization.

(g) *Another essential, voiced by Chapin, may well be added,* viz., in feeding young animals it is not only necessary to supply the proper quantities of nutritional elements, but they must be in such form as normally to develop the digestive tract.

This writer calls attention to the physical and chemical differences in the milk of various mammals, and shows that each is especially adapted not only to the nutrition but to the digestive development of its particular young—as, for instance, the bovine calf, which, doubling its birth weight in forty-seven days, attains pubescence in one year with a ruminant digestive tract twenty times the body length that must be fitted quickly to obtain food elements from coarse herbage. The calf needs a dense, quickly curdling, rich protein milk for early development of both muscular and secretory functions in his stomach, which constitutes seventy per cent of the digestive tract. The human infant, on the other hand, who doubles weight in one hundred and sixty days and attains puberty in fourteen years, finds only in his mother's milk the ingredients suitable for the development of the digestive tract, which is only six times his body length, and of which only twenty per cent is stomach. Hence, the early feeble gastric digestion must be slowly cultivated by gradually increasing density of the flocculent curds characteristic of human milk alone.

PROPRIETARY FOOD PERCENTAGES

Name of Food	Percentages						Source of Analysis
	Fat		Sugar	Protein	Starch	Ash	
Condensed Milk, Eagle Brand	9.61	54.94	Cane......42.91 Milk.......12.03	8.01	....	1.78	Own advertisement
Condensed Milk, St. Charles.	8.70	10.95	Milk...........	8.80	....	1.40	Jordon & Mott, *Am. Jour. Public Hygiene,* 1910, xx, 391
Ramogen	16.50	34.65	Cane......20.91 Milk.......13.74	7.00	....	1.50	Own advertisement
Mammala	12.12	55.34	Milk.......24.35	....	....	4.93	Mellin's Food Co.
Horlick's Malted Milk	8.78	67.95	Milk.......49.15 Malt........... Dextrose....18.80	.... 16.35	....	... 3.86	Own advertisement
Mellin's Food	0.16	79.57	Malt.......58.88 Dextrins...20.69	10.35	....	4.30	Own advertisement
Mead's Dextri-Maltose: No. 1		93.00	Malt.......52.00 Dextrins...41.00	....	....	2.00	Own advertisement[1]
Laibose	17.00	55.00	Milk.......25.00 Malt.......25.00 Dextrins... 5.00	18.00	....	4.00	Own analysis
Allenbury's Foods: No. 1 Milk	18.60	66.55	Milk.......42.00 Malt.......14.00 Dextrins...10.00	10.66	....	3.95	Own advertisements, except proportions of sugars. These given approximately from analyses made by Mellin's Food Co.
No. 2 Milk	15.88	70.90	Milk.......36.00 Malt.......20.00 Dextrins....13.00	9.90	....	3.71	
No. 3 Malted	1.05	25.11	Malt.......16.50 Dextrins... 8.50	10.23	60.01	0.60	
Eskay's Albuminized Food	3.52	55.82	Milk.......54.12 Dextrins... 1.70	6.70	29.90	0.99	Own analysis
Nestle's Food	5.50	58.93	Milk....... 6.57 Cane......25.00 Malt........... Dextrins...27.36	.... 14.34	.... 15.39	... 2.03	Own advertisement
Ridge's Food	0.26	7.80	Milk...........	12.50	73.67	0.61	Own analysis[2]
Benger's Food	0.92	3.34	Largely dextrins and sugars....	12.12	77.02	0.97	Own analysis[3]
Imperial Granum	1.04	1.80	Dextrose... 0.42 Dextrins....1.38	14.00	73.54	0.39	Holt, Diseases of[4] Infancy and Childhood, 1911, p. 162
Wheat Flour	1.00		....	11.40	75.10[5]	0.50	Bulletin No. 28, U. S. Dept. of Agric.

[1] Proprietors state that this analysis is only approximate, that the percentages of maltose and dextrin vary from 1 per cent to 2 per cent and that many samples show traces of protein and fat. "No. 2" is the same as "No. 1," except that it does not contain the 2 per cent of salt.

[2] Proprietors wish to emphasize the fact that the directions call for boiling, which "gelatinizes the starch in the form of colloids."

[3] Proprietors wish to call attention to the fact that the food contains active amylolytic and tryptic ferments which, when the food is prepared according to the directions, "convert the starch into subtle sugars and modify the casein."

[4] Proprietors wish to direct attention to the fact that Imperial Granum is intended to be used with milk.

[5] Total carbohydrates.

It has been stated that the substitute feeding of infants is a broad subject. If the breadth of this subject is indicated by the number and apparent variety of infant foods on the market, a student may well quail before it. To the query why such a large number of foods and preparations, the reply has been made that commercial enterprise is responsible for this, as it is also for the innumerable foods and preparations for adult

use; also that manufacturing ingenuity is stimulated to furnish presumed nutriment in a great variety of forms by the whims, caprices, and tastes of individual appetites.

A list of proprietary foods (see opposite page) is briefly outlined as given by Morse and Talbot, with short criticisms of a few of the more popular brands.

Man is an animal with educated or perverted tastes which result in a demand for variety in his viands. The adult is capable, also, of determining, to some extent, the nutriment derived therefrom. At any rate, he may recognize some of the more immediate effects following the ingestion of different foods. The infant, on the other hand, is but slightly conscious of food effects, either immediate or remote. Rarely in early life has he tastes, either acquired or perverted. Instinctively he craves nourishment, and is almost invariably satisfied with that furnished normally by the breast. Variety in form or flavor is neither desired nor desirable. Reference to the essentials above enumerated will show that uniformity of food, containing the five constituents, is what the infant requires and with which he is satisfied. The great variety of baby foods on the market is partly the result of prejudice and ignorance.

The average mother's withdrawing her breast from the infant is likened to a vessel at anchor in a safe roadbed, slipping the cable in the absence of the pilot, chart or compass. The baby knows not what he needs, the mother knows little more; but she can read, and the claims of the enterprising food agents attract her attention. Too often physicians, also, derive their supposed knowledge of infant dietetics from the same source.

The Clinical Application of Artificial Feeding.—It is well to keep in mind the six rules of Dr. Cotton if we would have the infant develop physiologically.

(*a*) That the long-continued use of food deficient in *fat* and *lecithin* tends to the production of malnutrition and rickets.

(*b*) Deficiency in soluble proteins retards all development. *It is slow starvation.*

(*c*) The use of cooked foods may result in scorbutus, hence even sterilized milk should not be administered continuously.

(*d*) Food which would not meet the requirements of nutrition for a long-continued period, because deficient in some essential constituent, may be used temporarily, as in traveling, weaning, or temporary removal from breast.

(*e*) Gastric digestion must be developed by some substance which furnishes soft coagula, for which purpose nothing is known to equal *milk*.

(*f*) It is not sufficient merely to correct dyspepsia, the infant must be nourished and show a gain in weight and strength.

With the essential elements of cow's milk well understood and not forgetting Dr. Cotton's six rules for artificial feeding, we must remember that success in infant feeding depends, not upon the particular method used, but upon the intelligence, the experience and the knowledge of the working principles of infant feeding which the physician possesses. Every infant is a law unto itself, and the essential law of success is the discovery of the infant's strength or weakness toward some one of the various ingredients of the milk. *Clean milk* is, of course, absolutely necessary to success in infant feeding. Infected or unclean milk cannot be made safe for feeding even if it is pasteurized. This knowledge is of more importance than the method of feeding. *Cream* is more easily contaminated than milk, and when over twenty-four hours old unsafe for infant feeding. If it is found necessary to increase the percentage of fat in an infant's formula, it should be done by taking it off the top of clean milk. Healthy common cows are safer than the Alderney or Jersey, in which the fat percentage is too high and the fat difficult to digest. Accordingly, the common cow is best for infant feeding.

Overfeeding, not only in calories, but in the number of ounces, is frequently disastrous to the child, no matter what formula is used. It is very important to respect the child's capacity; if we do not bring on digestive disturbances of an acute nature, we will eventually induce a dilatation of the stomach with chronic indigestion, which years of careful feeding will fail to overcome. To give an infant all he will take is a very common practice. We must remember the gastric capacity of infancy and feed accordingly. I have never given over eight or nine ounces at one feeding while the child was under one year. If we give more, we should increase the quality and not the quantity.

PROPER FEEDING INTERVALS FOR INFANTS OF VARIOUS AGES
(MORSE AND TALBOT)

Age	24 hour Amount	Number of Feedings, Amount and Intervals
1 week	10–12 oz.	10 feedings of 1 oz. at 2 hour intervals
		8 " " 1½ " " 2½ " "
4 weeks	20 "	8 " " 2½ " " 2½ " "
		7 " " 3 " " 3 " "
4 months	32 "	7 " " 4½ " " 3 " "
6 "	36–40 "	6 " " 6½ " " 3 " "
9 "	48 "	6 " " 8 " " 3 " "
		5 " " 9½ " " 3–4 " "

Artificially fed infants, like the breast-fed, should be given their food at regular intervals. This is important in order to obtain good results. The intervals may be one, two, three, four or five-hour periods to suit digestive capacity as well as age and weight of the child. Usually night feeding can be omitted after the fourth month. The feedings between 6 A.M. and 10 P.M. must be observed with the strictest regularity. When the child is about eight months old four feedings in the twenty-four hours are enough, beginning at 6 or 7 A.M. and finishing at 6 or 7 P.M.

While the infant is taking his food, he should be quiet, free from light and excitement. Food given while the child is surrounded by noise, light, and various members of the family, creates irritability and disturbs digestion, laying the foundation for many ills later in life. Infants should be taught to lie quietly and their surroundings should be quiet to secure profound sleep. The rapidly growing nervous system of the infant is easily excited by an outside factor, exerting an unfavorable influence on the digestive organs.

Good air is as important to the infant as clean milk, and as early as the first week in summer, provided the weather permits, the child should sleep out of doors during the day. During winter the first outings should consist in widely opening all windows. By the time the child is two months old, most of the sleeping during favorable weather should be in the open. Undue light and drafts can be controlled by the proper adjustment of couch, carriage or hammock.

The infant's food should contain the necessary elements, fat, protein and sugar, in reasonably accurate percentages in order to maintain good health. If fever occurs, as a result of improper food or feeding, or by reason of any acute infection, then the withdrawal of the milk-formula is necessary. As Jacobi well states, "Milk is food for infants when well, but food for bacteria when sick." After an illness has subsided, the gradual return of the whole formula is necessary—not omitting protein and fats, as so many do. Barley water, orange juice, or plain water will tide an infant over an illness lasting one week or more before milk can be resumed with safety.

It is a well-known fact that the fat of cow's milk is not easy to digest. It is necessary to remember this and to place the percentages of fat in modified milk-mixtures for young infants much lower than found in human milk. The excess of fat which is usually used too freely, is one of the most common causes of indigestion in young infants. When the child is restless, colicky, and has loose stools, the first correction in the

food formula to be made in the trial change should be a reduction of fat and a corresponding increase in calories, namely sugar. The further indications for this change in the food formula are, viz., (*a*) if the infant regurgitates its food; (*b*) or is constipated, with gray dry stools, and (*c*) if it voids irritating urine which stains the napkin with uric acid constituents.

The management of the casein of cow's milk usually causes the least trouble in our milk formula. Cow's milk casein may, however, be a cause of indigestion. After a reduction of the fat has failed to improve conditions, we are called upon to prevent the coagulation of casein in the stomach by adding a diluent or some alkali that will split up the coagulated casein. Sodium citrate in solution, a grain to one grain and a half for each ounce of food, is sufficient. Barley water may have to be used as a diluent, or it may prove necessary to boil the milk. Sodium citrate in solution is perfectly reliable and long experience has proven its value.

If, however, these measures fail and casein indigestion continues, we may reduce the casein content of our food formula and make up the deficiency by the addition of whey proteins. When this trouble is corrected, we can slowly increase the fat and proteins to the original formula. Casein indigestion is revealed by large tough curds, loose alkaline stools, fever, and irritability; the latter will be found a constitutional symptom.

The sugars are the most easily digested of the food ingredients of the modified milk mixtures, and for this reason are frequently increased at the expense of the fat and protein. For this reason we frequently find sugar intoxication in young infants. These cases are associated with a watery acid diarrhea, producing irritation of the buttocks. Fever, general constitutional symptoms, much gas formation and intestinal catarrh are usually present. When these symptoms occur, it is necessary to withdraw the sugar entirely, or what is possibly the best procedure, to substitute another sugar. Theoretically, milk sugar should be the first choice, but practical experience has demonstrated that cane sugar is better than milk sugar and that malt sugar is superior to both, so we use malt sugar in all of our artificially fed children.

HOME MODIFICATION OF COW'S MILK.—In feeding infants in the home under the physician's care, some modification or adjustment of cow's milk must be made to suit the individual infant—this is called "home modification" and does not refer to any exact changes to be made in the milk, except rendering it more suitable to the baby's digestive capacity and nutritional demands. Every physician of experience has worked out, for himself, a plan for modifying milk, which his clinical

experience has taught him will serve his purpose better than any other that he has been able to find, and nearly every writer offers his own formula for home modification of milk by which a certain degree of accuracy in percentage feeding may be obtained. This is a true statement, and is proof that there is no single method superior to all others. The infant is a changeable factor, as much as the milk ingredients—and the infant must be modified as well as the milk.

The prime object of these methods is to give the physician certain rules so he may arrange milk formulas containing definite percentages of protein, fat, sugar and salts. Nearly all existing methods of feeding are more or less complicated in the sense that they strive to give very exact percentages of protein, fat and sugar, in the idea that the exact percentage is necessary to success in feeding. This is not true for the formula, nor is it true for the infant. Very few physicians work out the exact percentage, nor is it necessary. While there can be no objection to accurate percentages in infant feeding, yet the experience of the world has demonstrated that these accurate percentages are not absolutely necessary to success, and that on the whole, infants thrive just as well upon a milk mixture which is intelligently modified so as to contain protein, fat, sugar, and salts in fairly definite percentages, and in such quantities that the infant will not suffer from starvation in any one of these important ingredients. By reason of the many complicated methods given in our text-books, most physicians resort to the use of whole milk and a diluent in the form of some malted sugar food. These simple mixtures appeal to the young mother and the result is that most of our infants are thus reared. The following table is taken from Morse and Talbot:

ANALYSIS OF WHOLE MILK VARYING CREAM PERCENTAGES SKIMMED AND SEPARATED MILKS

	Fat	Milk Sugar	Protein
Whole Milk	4.00	4.50	3.50
7% Cream	7.00	4.45	3.40
10% "	10.00	4.40	3.25
16% "	16.00	4.20	3.05
32% "	32.00	3.20	2.50
Skimmed Milk	1.00	5.00	3.55
Separated "	0.25	5.00	3.65
Whey	0.25	5.00	0.90

While the simplicity of the whole milk method of modifying infant feeding has made it popular, there is no question that much better results

can be obtained by a method which uses top milk as well as whole milk in the preparation of infant foods. In this way the fat percentages can be better adapted to the nutritional demands of the infant.

Feeding may be greatly simplified and its efficacy not materially diminished by making all food formulæ from three ingredients, viz., 1, whole milk, which to simplify computations one may assume contains 4 per cent fat, 4 per cent protein and 4 per cent of sugar; 2, top milk, containing 7 per cent cream—this is obtained by taking the top half of the milk after it has stood for two hours; this contains very nearly 7 per cent fat, 4 per cent protein and 4 per cent sugar; 3, a carbohydrate solution made of sugars or starches containing one-half ounce of carbohydrate to the pint.

In infants under six months of age, because of the great dilution of the milk, the 7 per cent top milk should be used, so as not to get a too low percentage of fat. In infants over six months of age whole milk may be used.

In making modified milk mixtures from these ingredients the physician should be guided by the principles underlying the artificial feeding of infants, as pointed out in the earlier portion of this chapter.

In the table it is shown how the ingredients may be combined in the production of an infant food which will answer all practical purposes. It possesses the proper number of calories, and contains the important per cent of protein, fat, sugar and salts in such relative quantities that the infant will be satisfied. After all, the true test of feeding is the child itself. If the infant gains in weight, six to eight ounces per week while under four months; sleeps well from twelve to fifteen hours in the twenty-four; doubles its birth-weight at six months and triples it at one year, we may well feel that the food is meeting all requirements.

Between the sixth and twelfth month the food of the average well infant should be supplemented by the addition of orange juice, raw egg albumen, thick cereal gruels, meat juice and meat broths. All this additional food should precede or follow the bottle, except orange juice, which should be given at least one hour after the bottle.

Milk should always remain the chief food of the infant and can be continued until the third year, or until the child has been taught to chew thoroughly the food suitable for its age.

After nursing, any food remaining in the bottle must be thrown away. Flies should never be allowed to touch the baby, food, or utensils. It should be understood that the mother or nurse will never touch the nipple with their lips.

The temperature of the milk may be tested before giving it to the baby by allowing a few drops to fall on the back of the hand.

The bottle must be held *inverted* by the mother or nurse during the feeding, so that the child will not suck air.

If the milk flows too freely, ofttimes a most perplexing problem in artificial feeding, the nipple needs changing, or possibly, a light gauze packing is required.

The time required to take six to eight ounces of food should not exceed twenty-five minutes of continuous nursing. This is necessary to develop the salivary glands and promote good digestion.

Regularity is of prime importance. The number and length of intervals should be about the same as those given for infants at the breast.

Water is of vital necessity and must be given at least three times a day; this is best done from a bottle, two to three ounces at a time. I am in the habit of ordering a small quantity of sugar or soda mint, or both, in the bottle. This is of value if the child is constipated.

It is a good rule to start with formulas of low percentages in commencing artificial feeding in normal babies. This is true of fats and proteins. Taking the mother's milk as a standard, the percentage of sugar and protein may be about the same, but the fats should be about one-half, remembering that temporary error on the side of underfeeding is much easier of correction than the more common mistake of overfeeding.

The final rule is to keep the child in a cool, quiet, and dark room where all external irritations are reduced to a minimum.

Summary of Rules to Be Observed in Artificial Feeding

The aseptic care of the bottles, nipples and utensils, including the person of the nurse or mother, cannot be over-emphasized. This rule is as important as clean milk, and without clean milk the first and most important link in the chain is broken. The once familiar death-trap known as the long-tube nursing bottle, still frequently seen in children's dispensaries, has at last attracted the attention of legislators, so that in many localities not only the use, but even the sale is prohibited by law.

In the *home modification of milk the mother or nurse* must be carefully instructed by the attending physician in regard to all details. All the necessary utensils should be on hand for the proper and scientific preparation of the baby's aliment. These include a good medium sized *ice box, two siphons, sterilizer,* or *pasteurizer, thermometer* registering to 212° F., a *dozen graduated feeding tubes or bottles* (large mouth without shoulder with small lip), *bottle brushes, absorbent cotton, straining*

gauze, non-absorbent cotton for use as stoppers, *mixing pitcher, glass funnel, tall cup* for warming bottle, *six black rubber nipples* (reversible for cleaning), *package of bicarbonate of soda* and *boric acid.*

Lime water should be kept in a well-corked bottle. The *sugar* (malt or cane) solution should be prepared fresh for each day's use.

The supply of food should be prepared once or twice in the twenty-four hours, dependent upon the time of the milk delivery, and the number of tubes to be used. The milk should always be kept on ice before and after preparation.

All bottles and utensils should be washed with *hot soap-suds,* then *boiled* and *rinsed.* The *feeding tubes,* after boiling, should be filled with *hot boric acid* or *soda solution* and left covered until used again. The tubes, when filled, should be stoppered with non-absorbent cotton so that in cooling the air may pass through. After warming to about 100° F. by standing the bottle in a cup of hot water, the cotton in the bottle is replaced by the nipple. The nipples must be boiled daily and then kept dry in a closed box.

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CHAPTER XVI

SPECIAL DIETS

H. LYONS HUNT, M.D., L.R.C.S. and P. (Edinburgh), L.F.P. and S. (Glasgow)

Food, and only food, makes blood, and blood, as we know, makes body; so that our body structure is dependent upon, and only upon, the food we eat.

Vegetable Diet: Vegetable Diet and Energy; Vegetable Diet and Health; Vegetable versus Animal Protein; Summary.
Meat Diet: The Salisbury Diet; Zymotherapy.
Fruit Diet: Fruit Diet in Disease; Lemon Cure; Grape Cure.
Tufnell and Bellingham Diets.
Weir Mitchell Diet.
Training Diet.
Reducing Diet.
Diet for Professional Singers and Lecturers.
The Dry Cure.
The Yolk Cure.
Milk Cures: Kumiss Cure; Matzoon Cure; Buttermilk Cure; Sour Milk Cure; Milk Cure; Skim Milk Cure; Whey Cure.

From time immemorial man has fed on the fruits of the earth and the flesh of animals. At certain epochs in his history, under the sway of philosophic speculation or religious tenets, sometimes on account of careful hygienic considerations, or even under force of necessity, he has, voluntarily or not, subjected himself to special forms of diet, sometimes eating only fruits and herbs, sometimes adding milk to his fruits and vegetables. At other times, on the contrary, his alimentation has been exclusively from the flesh of animals, and again he has seen fit to subsist upon a mixed diet, to the rigid exclusion of all meat. These exclusive methods of alimentation have led to favorable hygienic and dietetic results which find ready application in trophotherapeutic treatment.

Various systems of special diets and diet cures have been devised to meet the requirements of disease or the fancies of the faddist. Some of these consist solely in the elimination of certain articles of food from the dietary, due to esthetic tastes or humanitarian principles. In some instances the particular modification is based on trophotherapeutic reasoning with a view of economic simplicity, the desire to give the digestive apparatus a complete rest from some particular food constituent, or the necessity of curtailing the amount of nutrients in the dietary without reducing the actual quantity of the diet or of limiting the total caloric value. Many of the special diets and diet cures which embody this object are outlined in the present chapter; and those prescribed in obesity are referred to in the section dealing with Diet in Diseases of Metabolism (Volume III, Chapter XII). The dietaries here considered are of practical use in various conditions of health and disease, in different individuals in different climates, or in the same individuals under different environments.

VEGETABLE DIET

Vegetarianism(1), or a vegetarian diet, will be the first of the special diets and diet cures to receive attention, because, in one form or another, it is, and has long been, the alimentation of entire races of people numbering many millions, and of late years has become a fad with many Americans and Europeans, who find it more economical to patronize the green grocer than the butcher, and who believe, in many instances, that a vegetable dietary is conducive to health, longevity, good temper and a mildness of disposition which a carnivorous dietary obliterates. Often, too, believers in this special form of dietary object to the flesh of animals for esthetic or religious reasons, since they consider the slaughter of animals unjustifiable to furnish food for man.

A dietary which excluded the flesh of all animals was at first a religious practice. The Hindoos, followers of Brahma and Buddha, believers in the doctrine of the transmigration of the soul, still hold to the teaching that the spirit can migrate from man to animals, which are our inferior brothers. It has, therefore, always been repugnant to followers of this cult even to think of eating the flesh of an animal, which to them is a kind of sacrilegious cannibalism. For a similar reason the religious beliefs of the ancient Egyptians forbade the use of meat, this doctrine having been brought by Pythagoras(2) from that country into Greece, whence it has been transmitted to us by time. The human race is omnivorous by instinct, by its dentition, by its digestive secretion, and by its need of ac-

tivity. To work quickly and well, the modern man, especially, must have a stimulating dietary which will furnish him with the most active and most digestible plastic matter in the smallest volume. A diet of meat and vegetables seems to agree with him from every point of view.

The strict vegetarian partakes of no animal food, and no tubers nor foods grown under ground, limiting his alimentation entirely to fruits and vegetables grown in the sunlight. Many vegetarians, however, in addition to vegetables, consume milk, butter, cheese and eggs, and are classed as lacto-vegetarians. In reality they are no more vegetarians than the man who eats meat, fish or fowl. The alimentation of the lacto-vegetarian, consisting of milk, cheese, butter, eggs, cereals, legumes, fruits, nuts and other vegetables, is advantageous to many people and more particularly in the trophotherapeutic treatment of certain types of disease. Vegetarianism has its advantages in that its supporters do not overeat while getting a fairly bulky meal; the amount of protein consumed is smaller and the proportion absorbed is less from a vegetarian diet than from a mixed diet, which is of great advantage to many patients. A lacto-vegetarian dietary, such as the following from Tibbles(3), is valuable in the dietetic treatment of high arterial tension, the forerunner of arteriosclerosis, of some forms of renal disease, as albuminuria, and of Graves' disease, gout, calculi, hepatic troubles, rheumatism, intestinal toxemia and intestinal fermentation, chronic skin diseases and chronic nervous affections.

LACTO-VEGETARIAN DIET

Breakfast:

Milk, whole meal bread, butter, one egg.

Lunch:

Baked beans and tomatoes, potatoes, cabbage, stewed fruit, bread, cheese, and salad.

Dinner:

Lentil soup or oatmeal porridge, bread and butter, dates and walnuts, or grapes and bananas.

This dietary can be varied in many ways. The use of sauces, such as walnut and mushroom ketchup, or ripe tomatoes, added to beans or macaroni, makes them more palatable and gives zest to the appétite and at the same time provokes the stimulation of the secretion of gastric juice. Beans and peas boiled with savory herbs—mint, thyme, savory, marjoram, etc.—are more palatable and better flavored than when cooked without them. Lunch is generally more difficult to provide than the other meals. The following dietaries outline lacto-vegetarian lunches for a week:

LACTO-VEGETARIAN LUNCHES

Monday:

Steamed rice and tomatoes, with grated cheese; boiled cabbage or other green vegetables; whole meal biscuits; custard pudding.

Tuesday:

Steamed broad beans and macaroni, with parsley sauce; steamed green vegetables; potatoes cooked in their skins.

Wednesday:

Nut-roast, mushroom gravy; steamed vegetables; plain steamed pudding with jam or syrup.

Thursday:

Macaroni and cheese, with apple sauce and steamed potatoes; ginger pudding; fruit.

Friday:

Baked Irish stew containing nut-meal or peas or beans in place of meat; milk pudding; unfermented bread; cheese.

Saturday:

Lentil-roast with apple sauce or gravy; boiled cabbage; baked or steamed potatoes; maizene pudding; nuts and fruit.

Sunday:

Savory pie, consisting of steamed haricot beans and vegetables; or macaroni and eggs, moistened with milk and seasoned; baked potatoes; tomatoes and salad; ground rice, blanc mange; fruit.

It is no longer questioned that a dietary composed entirely of vegetables will supply all the food constituents, carbohydrates, fats and proteins. A menu can be planned so as to supply all the necessary food elements requisite for body metabolism. The nitrogenous matter obtained from vegetables, however, is less easily digested than that from animal foods, and a much larger percentage passes from the alimentary tract unutilized. Individuals subsisting entirely on a strict vegetarian diet for any prolonged period of time are apt to lose strength as well as physical and mental vigor and endurance and show languor and disinclination for work, and they become less able to resist disease(4, 5). Laborers are unable to perform the same amount of work they could accomplish on a dietary containing animal food. As previously stated, the animal kingdom supplies man with protein food, and the vegetable kingdom provides carbohydrates except honey; fats being derived about equally from both sources. The percentage of starch in different vegetables varies greatly, being highest in tubers. Green vegetables are practically fat-free, containing a very small percentage of protein, one-tenth of which is lost in cooking, and from two to eight per cent of starch, of which one-third is lost in cooking. They possess the advantage of being able to take up a great

deal of fat during the process of cooking. Fats are negligible constituents of vegetables, but are apparently quite as nutritious and even more digestible than animal fats. A careful consideration of the elementary constituents of a vegetable dietary shows that the principal advantage of a strict vegetable diet is the reduction of all protein, notwithstanding a large bulk of vegetables may be taken. The exclusion of animal foods, with the exception of eggs, milk and milk products, from the diet is strenuously advocated by certain sentimentalists who are opposed to slaughtering animals for food.

According to Edmund Caultey(6), universal lacto-vegetarianism is an impossibility.

> Carried out thoroughly to its logical conclusion it would have a most profound effect on life generally. Under such a scheme of diet all animals except those used for draught purposes and pleasure would gradually be abolished. Were fowls only kept to supply eggs and feathers, the price of eggs would rise considerably. So, too, the supply of milk would be insufficient and its price prohibitive, for cattle could not be kept profitably for the supply of milk and leather alone. Woolen clothing would become the luxury of the rich. The bulk of the grass grown would be absolutely wasted unless the science of the vegetarian were able to prepare from it a food for man.
>
> The productive value would be, however, increased if the grass plains were converted into arable land for the growth of cereals and sugar beets and into orchards for fruits and nuts. We should have an insufficient and expensive supply of milk, milk products, and eggs, wool and leather. We should be dependent on cotton and linen for clothing and on compressed cellulose for boots and many other purposes.

But although universal vegetarianism is opposed to the scheme of nature, there are cases in which the diet, or one modified by the addition of milk and eggs, is particularly suitable. As has been stated above, its advantage largely depends on a relative starvation, when compared with the previous mixed diet. The patient no longer overeats. Vegetarians claim that they live longer and are healthier, physically and morally, than flesh-eaters, and it is true that they may be healthier, physically, if they have been subject previously to ailments due to an excess of nitrogenous food or overeating generally. The diet is more suited to those engaged in hard physical work, for they sweat freely and get rid of the excess of water in the diet, and they require much carbohydrate food to provide for muscular energy. A sedentary person on a vegetarian diet is liable to develop a distended, flatulent abdomen, watery blood, and diarrhea from the excessive peristalsis set up, while the excess of waste products puts extra work on the organs of excretion.

Tibbles(3) does not agree with the assertion that vegetarianism leads to mildness of temper or to gentleness of disposition. He points out that the buffalo, the rhinoceros and the Chinese pirate, all vegetarians, are equally remarkable for their cunning and ferocity. It is universally known that the carnivora are more active, more alert and more powerful than the herbivora, while the meat-eating races of man are physically superior to those who subsist entirely on a vegetable diet. He also calls attention to the superior physique of the American or European soldier over that of the Japanese or Chinese. Again, the races of mankind who subsist on a mixed dietary are more progressive and more alert than the vegetable-eating races. We learned when studying Protein and Nutrition that the Japanese as a race have made wonderful progress since the adoption of a larger protein ration and especially since eating animal food. This same statement applies equally to the Chinese, Siamese and Burmese.

Vegetable Diet and Energy.—The principal influence of a vegetarian diet on metabolism is a lessening of many of the vital forces. According to Tibbles, "The influence of vegetarian diet is to slow down many of the vital processes, to make the person, if anything, less energetic, or of a quieter disposition only in proportion as all his functions become somewhat more languid. That animal food is proper for children is suggested by the fact that milk is the natural food of infants and young children. It may be admitted that less animal food than the amount usually consumed is quite sufficient, and it is probable that two-thirds of the amount of protein required might be derived from vegetable sources." Hueppe is the authority for the statement that "man was originally a mixed feeder, but evolved into a flesh-eater, and lastly into a vegetarian; but vegetarianism only became possible after the introduction of fire and discovery of the art of cooking. Man has neither the teeth nor the gut of a vegetarian animal, or he would naturally graze in the fields in the summer, and in winter eats oats from a manger."

As a source of energy, there can be no possible advantage in adhering to a vegetable dietary, but on the other hand, there is a decided disadvantage owing to the vegetarian diet being more difficult of digestion. The amount of energy expended in the performance of bodily functions and the amount expended under various conditions and circumstances has been fully discussed in a previous chapter. It has already been stated that the required energy can be obtained from a purely vegetarian diet provided the amount consumed is sufficient, but a strict vegetarian diet does not appear to give the amount of strength obtained from a mixed diet. This view is generally held and is well expressed by Tibbles(3):

No vegetarian animal can lift the weight of his own body, not even the horse, ox, camel, or elephant. On the other hand, the carnivorous lion, gripping a calf his own weight, can jump a hurdle six feet high. The lifting power of man, the mixed feeder, exceeds that of any other mammal. It is recorded of Louis Cyr that he lifted 2,672 pounds; of Little, that he carried 1,560 pounds for fifteen steps; of a Tyrolese, that in six hours he carried a load weighing 262 pounds up an ascent 5,000 feet high. A laborer weighing 165 pounds, working around the New York docks, will many times a day carry a sack weighing 220 pounds. A negro helper on the freight trains in the South will carry a 500-pound bale of cotton and think nothing of such a feat. The street porters of Salonica and Constantinople, who feed on pillaf of rice and figs, with a little meat, are noted for their proverbial strength. It is not at all unusual to see one of them carrying a grand piano about the streets on his back. Hence the saying, "As strong as a Turk."

Vegetable Diet and Health.—Vegetarian faddists claim that a strict vegetable diet is more healthful than a mixed diet, also declare that it tends to health and longevity, but statistics show that the vegetarian is just as liable to disease, and possibly more so, through his food than the flesh eater. Vegetarians also claim that meat causes diseases of the liver, gout, stone, gravel, chronic rheumatism, skin diseases, disturbances of the vascular system, arteriosclerosis, and other similar diseases; that ptomaine poisoning may follow the ingestion of animal food; that the animal whose flesh is consumed may have been the subject of anthrax, glanders, foot-and-mouth disease, or some of the various other maladies communicable to man. They also assert that oysters and other shellfish are a causative factor in outbreaks of typhoid fever. Many instances, however, can be cited to show that a vegetable diet may also be the means of disseminating diseases. Bread and other starchy foods from the vegetable kingdom taken in excess lead to indigestion, flatulence, acidity, congestion of the liver, and hemorrhoids, and tend to obesity, while overmilled rice is the cause of that scourge of the East known as beriberi, or kakke. While sugar possesses enormous value as a provider of energy, if ingested in excess it will produce evils similar to those following an excess of starchy foods, especially catarrh of the stomach. Again, the ingestion of hard fruit, nuts and fibrous vegetables may be a contributing cause to digestive difficulties. Animal foods are by no means the only source through which disease may be transmitted. Practitioners in the tropics invariably give this advice, "Eat no uncooked vegetable, nor any raw fruit, unless you can pare it or peel it." Outbreaks of typhoid fever, dysentery, cholera, diarrhea and various other diseases have often spread from disregard of this warning, and the consumption of imported raw,

unripe or over-ripe fruit is frequently a cause of tropical diseases in temperate countries. Nor is it safe to eat any variety of fruit purchased from the fruit stands of our northern cities, without peeling, as the fruit vender often has the industrious habit of polishing his apples with a rag on which he frequently spits. Again many diseases are communicated from the ingestion of green vegetables, more especially that class of diseases produced by animal parasites. Hydatid disease, one of the most terrible of this type, is caused by the Tænia echinococcus, a small tapeworm which is taken into the body in the form of ova or partially developed Tænia on green vegetables, such as watercress, celery, lettuce, etc. Actinomycosis also enters the organism with green vegetables and cereals, while ergotism is a disease common among consumers of rye bread. Pellagra and beriberi are deficiency diseases due to vegetable foods, which will be considered elsewhere in this work.[1]

Tibbles coincides with Hueppe's opinion that the supposed health-giving properties of a strictly vegetarian diet are questionable. "The vegetarians of our time," Hueppe avers, "belong to the class of neurotic men who, failing to meet the strain of town life, ever seek for a 'heal-all' in one or another crank. Their doctrines, pushed with fanatic zeal, make no impression on the healthy, and only tend to overthrow the balance of others, who, like themselves, are the victims of unnatural modes of existence." Waylen(7), himself a believer in this cult, and one who had intimate acquaintance with many vegetarians, in writing on this subject says that for eight years he was a vegetarian, wore sandals and went without a hat; but it gradually dawned upon him that man is somewhat different from the beasts; that if a monkey can do something, it does not follow that a man should do likewise. He says: "Vegetarians as a rule are not healthy folks. They present either a wizened and emaciated appearance or a tendency to flabbiness. They have a poor circulation, and are liable to chills. They suffer from dyspepsia, flatulence, bad breath and anemia. Their liver and kidneys are commonly affected, and altogether there is a want of vitality among them. They burden their stomachs with masses of crude stuff, and practically deprive themselves of fat and oil; and while they daily grow thin and nervous, they think they are improving in health." Waylen in summing up this question says that when the human body is starving, it begins to feed upon itself, and vegetarians may be charged with being guilty of a species of cannibalism.

We have already shown in "Feeding in Health,"[2] what the influence

[1] Volume III, Chapter XVII.

[2] Chapter X, this volume.

of flesh food is on the character of animals, and this we will supplement by the opinions of two celebrated men who were keen observers of themselves:

Porphyre(2), a philosopher who gave up the Pythagorean doctrine to eat meat, in writing to his friend Firmus, says:

> It is not amongst the eaters of simple and vegetable foods, but amongst the eaters of flesh, that assassins, tyrants and thieves are met with. I cannot believe that your change of diet is due to reasons of health, for you yourself have constantly affirmed that vegetable diet is much more suitable than any other, not only to give perfect health, but even a philosophic and balanced judgment, as a long experience had taught you.

And Seneca, who, preoccupied with the same considerations, had slowly adopted vegetarianism, writes:

> Struck by such arguments, I also have given up the use of the flesh of animals, and at the end of a year my new habits have become not only easy to me, but delicious; and it even seems to me that my intellectual aptitudes have been more and more developed.

We learned when studying foods from the vegetable kingdom that green vegetables and fresh fruit are absolutely necessary to the well-being of mankind, but particularly for the inhabitants of the cities and towns. Scurvy, which once was a scourge, is now rarely seen, due largely to the fact that all people realize the necessity for adding fresh vegetables and fruits to the dietary. As previously stated, fresh vegetables, potatoes and fruit contain certain salts which are absolutely essential to the proper constitution of the blood and other fluids of the body. "If these salts are withheld from the dietary," according to Tibbles, "the blood becomes impoverished, and scurvy results"(3). The necessity for vegetables and fruit in the diet, therefore, cannot be denied, but, at the same time, we must insist that an exclusive vegetable diet is inconsistent with the ability of man to live upon all kinds of food; that vegetable foods alone entail a larger amount of work on the digestive organs; and that they do not furnish sufficient stimulating energy for our present mode of civilization. It is an admitted fact that some people feel better on a vegetarian diet than one containing meat. Plethoric individuals often complain of physical hebetude and want of energy after a heavy dinner of hot meat with the usual accompaniments, but are free from these symptoms after partaking of a vegetarian meal. We have shown in a previous chapter that the wealthy classes, who have the opportunity and can afford the luxury, dine too often and partake too freely of meat and game, and as a consequence they are troubled with disorders little known among vegetarians. How-

ever, a vegetarian diet, as a rule, is not more healthy than a mixed dietary, nor does it give an assurance of a longer life. Moreover, insurance statistics place less value on the life of a vegetarian than on the life of the average American or European who subsists on a mixed ration. According to Tibbles, there are large numbers of people who live on a more or less vegetarian diet. "The peasantry of Ireland subsist upon a dietary consisting largely of potatoes with a little milk, eggs and pork, occasionally replacing potatoes by oatmeal. This dietary is also that of the poorer classes in Scotland. The lower classes of Germany and Russia live largely upon rye bread, potatoes and fat. The Italians subsist upon cornmeal, chestnuts and acorn meal. In India and China the poor live largely on rice, millet and vegetables, with more or less pulse and other legumes."

Wait(9), of the United States Department of Agriculture, reports an investigation of the dietary consumed by a subject under a two weeks' observation. A small amount of meat was added, as a seasoning to the peas, the digestibility of which was the main object of the research.

WAIT'S VEGETARIAN AND FAT DIETARY

Ration	Total Food for Four Days	Contents of Food: Grams				Energy, Calories
		Protein	Fat	Carbohydrates	Ash	
	Grams					
Bread	1,170	112	11	679	11	3,600
Milk	2,600	81	138	132	18	2,182
Butter	130	2	116	....	4	1,048
Pork	78	4	71	....	2	670
Bananas	910	11	7	183	7	817
Sugar	130	...	....	130	..	515
Peas	1,100	219	16	684	39	4,299
Total		429	359	1,808	81	13,131
Daily average		107	90	452	20	3,283
Proportion digested: total food per cent		78	97	94	64	88
Proportion digested: peas, per cent		67	94	85	49	75

Vegetable versus Animal Protein.—In studying the subject of protein and nutrition(1), we found that the protein of vegetables is not so readily digested, absorbed and assimilated as the proteins from animal food. During the process of digestion a much larger proportion of nitrogenous compounds escapes the influence of the digestive ferments and hormones, principally due to the difference in the solubility of the connective tissue

enveloping the animal cells and the cellulose surrounding the vegetable cells. It is easily understood, therefore, that, in order to secure from a purely vegetarian dietary the amount of protein usually considered necessary for the organism, a great deal more labor is demanded on the part of the digestive organs than is required in the digestion of animal protein from an ordinary mixed diet. We have previously pointed out the fact that it is more economical to secure protein from legumes than from meat, milk or eggs, and for this reason, the use of legumes should be encouraged where the diet is deficient owing to a limited income.

The question whether vegetable protein has the same physiological value when absorbed as animal protein is a debatable one. Vegetarians claim that vegetable proteins are specifically different in their action from animal proteins. They go so far as to make the statement that they have a different effect on the body, and also on the character and morale. Our present knowledge of the demolition of the protein molecule is such as to lead us to question that any specific difference exists. Moreover, we do not think the point a good one for vegetarians to raise, for it is barely possible that animal protein requires a less complete deamination than vegetable protein prior to assimilation. We all know that the protein molecule is composed of twenty or more amino-acids and that the proteins of animal foods have been constructed out of vegetable proteins eaten by an animal. Physiologists tell us that the same kind or the same proportion of amino-acids is not contained in all proteins, the principal difference being one of percentage or proportion. We believe the consensus of opinion at the present time is that it matters little whether the amino-acids are obtained from the animal or vegetable foods, that whatever their source they have practically the same value.

At best, a vegetable diet furnishes a low protein alimentation, and this deficiency is one of its greatest disadvantages, especially among the poorer classes, in the case of growing children, who are so much in need of a bountiful supply of protein to build up their tissues. As we have previously recorded, it is possible to maintain the nitrogen balance in equilibrium when the amount of protein actually absorbed is around 56, 58 or 60 grams daily. An adult can maintain this equilibrium on a low protein diet, but this cannot be done in the case of a child. Physiologists who have given this subject great attention claim that a low average of protein in the food is one of the chief causes of the high mortality among the children of the poor(10). It has been stated by competent authority that "the protein of vegetables is not as valuable from a nutritive standpoint as the protein from animal foods." But protein is protein, whatever be its ori-

gin; albumin or globulin is of the same nutritive value whether it be obtained from animal or vegetable foods. It has been well said by Tibbles, however, that we cannot get away from the practical fact that meat gives a greater degree of energy than peas or beans. Vegetarians may deny this, but it is founded on general experience that a man has a more buoyant feeling when living on an ordinary mixed diet than when living on a strict vegetarian diet. It has been authoritatively stated that most vegetarians are neurotics. They do not possess the energy, activity and endurance of an ordinary individual. Tibbles explains this as follows(3):

Given an equal amount of protein from the two sources, they have an equal value so far as anybody can tell. The proteins in animal foods are albumins and globulins; those in vegetables belong chiefly to the class of globulins. There are nucleo-proteins in both animal and vegetable foods. The non-protein nitrogen of animal foods consists chiefly of the extractives, creatin, creatinin, xanthin, hypoxanthin, carnin, urea and uric acid; that of vegetables is chiefly in the form of amides and amino-acids—leucin, tyrosin, asparagin, etc. Herein lies the chief difference in the properties of animal and vegetable protein foods. The extractives of animal foods are more stimulating than those of vegetable foods. It is not contended that they give greater bodily strength. Energy is not to be confounded with muscular strength; energy is the property of the nerves, strength of the muscles. Physical work is done by the muscles, but it is initiated and controlled by the nervous system. The extractives of meat are valuable nerve stimulants. Leucin, tyrosin, and other amino-acids of a like character are not stimulants, and, unless they are utilized by the cells of the intestinal mucosa in the construction of proteins, they pass on to the liver, where they are broken down into urea, uric acid, and ammonia. If they are too abundant to be broken down by the liver, they affect the organism adversely and give rise to some of the symptoms of intestinal toxemia. The last argument has been applied with equal force to the extractives and purin bodies in meat. But the display of energy by the carnivora is very much greater than that exhibited in general by the herbivora, and this is accounted for not only by the greater consumption of protein, but by the different character of the associated non-protein nitrogen compounds.

The question has been asked, "Has the character of the protein any influence upon the development of organs and the performance of their functions?" This subject was alluded to when studying the section on Protein and Nutrition(1). The great importance of protein in the alimentation cannot be too strongly emphasized. In a previous chapter, we stated that during the period of growth and development of the body an abundance of protein was necessary. It is generally acceded to by physiologists that a low protein diet is unsuitable for growing children and young adults. Notwithstanding this fact, there are many thousands of

growing children in the East Side districts of New York, for instance, who subsist on a diet very low in protein. The question before us is, however, "Does the *kind* of protein influence this period of growth?" Tibbles points out that the consumption of meat in England at the present time is seventeen times greater per person per annum than it was in 1850. During the intervening period he declares there has been a very marked decline in the birth rate. He also records that this decline is most marked in the classes of society who have an unrestricted allowance of the more expensive proteins of meat, game, fish and fowl. In our own country, and especially in New York City, the most fertile families are the poorest classes in the East Side tenements, whose consumption of animal protein is restricted for economic reasons and naturally whose proteins are chiefly derived from the vegetable kingdom. It has been pointed out by some authorities that the increasing consumption of animal foods affects the development of the organs of generation, "acts prejudiciously upon reproduction and lactation, and is thereby an important factor in the causation of the declining birth rate and diminishing power of lactation." This opinion, it is claimed, has been confirmed by experiments on animals(3). Tibbles, in discussing this subject, says:

> The fecundity of the poor and comparative sterility of the rich in highly civilized communities is a matter of common knowledge, but to claim that one condition is due to a vegetarian or low protein diet and the other to animal proteins or a high protein diet, is at present beyond our power of conception. There is in fact very good evidence that a flesh diet does not diminish fecundity when the consumers live a normal life. The Eskimo women are not sterile, and the Indian women who subsist largely on a flesh diet are fertile. The Boer women eat meat at every meal, new vegetables and potatoes being seldom seen on their tables; nevertheless they are most prolific and feed their children at Nature's fountain.

Summary.—By way of conclusion, we will summarize the main points in this section in favor of and against vegetarianism.

(*a*) Foods from the vegetable kingdom are rich in carbohydrates and poor in protein and fat. They are bulky from their richness in starch, from the presence of cellulose, and from the large amount of water. (*b*) The foods from the animal kingdom are rich in protein and fat, and, with the exception of milk, poor in carbohydrates. They occupy little bulk in the raw state, and even less after cooking. (*c*) Foods from the vegetable kingdom are less easily digested and on the whole less completely absorbed than foods from the animal kingdom; owing to their bulkiness and the indigestible cellulose which invests their nutritive constituents

they are prone to fermentation in the alimentary canal, with the production of acids which tends to augment peristalsis. The protein constituents of vegetable foods are more difficult of absorption than protein from animal food. (*d*) A strictly vegetarian diet is apt to be deficient in protein, due to its imperfect absorption, so the question of vegetarianism becomes a question whether it is advisable to live on a low protein diet or not. (*e*) The strict vegetarian, who subsists entirely upon foods grown in the sunlight, must either live upon a diet relatively poor in protein or else consume an excessively large amount of food. (*f*) Statistics seem to emphasize the point that a strict vegetarian aliment tends to diminish energy, both mental and physical, as well as the power of resisting disease, and if a vegetarian attempts to consume sufficient food to yield the required amount of protein, the bulkiness of the diet is apt sooner or later to lead to derangement of the stomach and bowels. (*g*) Both of these results may be overcome by supplementing the vegetable part of the diet with animal substance rich in protein, but a large part of the necessary protein can be safely taken from the vegetable kingdom. (*h*) Milk and milk products, eggs, fish and meat may be used as protein carriers, but for persons in a normal condition of health the moderate use of meat and fish is advantageous. For the individual of a gouty diathesis, possibly milk and cheese are preferable, while skimmed milk or buttermilk and the cheaper kinds of cheese will be found more economical. (*i*) From an economical standpoint, there is no doubt that it will pay to patronize the green grocer instead of the butcher in purchasing the necessary food elements for subsistence. Vegetable foods can be purchased to better advantage both as sources of building material and energy than animal foods, so that vegetarianism may be recommended on the grounds of financial economy. (*j*) It is a fact that vegetable foods are less highly flavored and less appetizing than some of the animal foods, but they have the advantage of not being liable to undergo putrefaction and of rarely producing disease.

MEAT DIET

An exclusive alimentation from the flesh of animals is sometimes accepted through necessity. There are certain individuals who think that meat forms the most nourishing and most fortifying food. In fact, some men who are obliged to live a very fatiguing life, as the northern trappers and hunters, and the inhabitants of excessively cold climates, such as the fishermen living on the banks of the frozen seas, can subsist almost entirely upon enormous quantities of meat or fish without suffering any

untoward effects. Two conditions are, however, essential: The meat must be ingested with its fat, and the individuals partaking of such a diet must lead a very active life in the open air.

There is no evidence to lead us to believe that the primitive peoples of antiquity were vegetarians, for the adaptability of the human body to the use of animal foods, as well as our earliest historical records, disproves this; while some of the most savage peoples of the present time subsist almost exclusively on fish and game. Darwin records that the gauchos of the American pampas can sustain themselves for whole months on the fat meat of the oxen over which they watch. The Eskimos can devour five to six pounds of reindeer meat per day and almost twice that amount of the fat and flesh of the seal, concerning which we have already made mention. This diet of animal food becomes unbearable if the meat is all lean. Gautier has made some experiments on dogs with a lean meat diet. A dog weighing 40 pounds required 1,500 grams of lean meat as the necessary requirement to keep its weight constant, whereas 400 grams of meat, 200 grams of fat or 100 grams of meat, 100 grams of milk and 300 grams of bread were amply sufficient to obtain the same result. The findings from this experiment hold good in the case of man. In order to secure the 280 grams of carbon necessary for the repair of his organs and the discharge of his functions, 1,600 grams of lean meat would be essential for the average man. This quantity would introduce as pure waste four times more protein than could be metabolized. Such enormous quantities of meat from the point of view of hygiene and economy could only lead to unfavorable conditions; besides, no one could for any length of time consume such enormous quantities of meat without suffering from symptoms of auto-intestinal intoxication. A mixed alimentation composed of a rather larger percentage of meat than the standard requirement permits of furnishing the system, in the least bulk, with the greatest amount of the most nitrogenous, stimulating and useful food principles.

However, it would be erroneous to conclude that an alimentation enriched in meat to the point of being exclusively carnivorous would increase the physical power of the subject. Although a dietary taken exclusively from the animal kingdom raises the nitrogenous coefficient in comparison with a mixed or vegetable alimentation, a meat diet acidifies the blood and hinders oxidation. It overburdens the organs of excretion with a superabundance of nitrogenous waste, urea, uric acid, etc.; it congests the liver; it causes obstinate constipation; it brings on dyspepsia, gastric disturbances and enteritis; it induces intestinal putrefaction and intestinal stasis; it brings about rheumatic, arthritic, gouty and nervous

tendencies. A dietary not exclusively meat but only too rich in meat could not be borne for long. According to Huchard, such a diet would produce arterial hypertension and heart fatigue, and sooner or later become an active predisposing cause of arteriosclerosis. Houssaye has shown that in the case of fowls, an exclusive meat diet produces sterility and causes an arrest of development with an excessive proportion of males.

In view of the foregoing facts, then, an exclusive diet of flesh, or even a mixed diet wherein meat is liberally ingested, is not looked upon favorably from any point of view. A dietary composed too largely of meat tends to make individuals more aggressive, more headstrong, and the intelligence less keen. The well-to-do classes are too carnivorous. According to Herbert Spencer(11), there is a marked contrast between the children of families where the diet is largely animalized and those where the diet is largely potatoes and bread. From both points of view, that of physical and that of intellectual vivacity, the peasant's' child is far inferior to that of the gentleman. From the point of view of physical health and strength in actual life, Spencer's dictum does not appear to hold good; as to the intellectual vivacity of the child in the well-to-do classes of society, it is far more influenced by heredity—the selection of progenitors—and by educational advantages.

An exclusive meat diet has long been used in the dietetic treatment of tuberculosis, on the assumption that the association of gout with high living is largely due to the free ingestion of animal food; that a gouty condition can be artificially brought about through a dietary consisting largely of flesh foods; and, as is held by some, that there is an antagonism between a gouty diathesis and a tuberculous tendency. The main object, therefore, of an exclusive carnivorous diet is to induce that condition which is believed to be antagonistic to the growth of Bacillus tuberculosis or its toxins(1). When a meat diet is ordered, the meat must be freed from bone, gristle and connective tissue, and only slightly cooked. It must be taken in quantities sufficient to yield energy or fuel value to supply the heat expended by the body—2,000, 2,700 calories or more, depending upon the condition of the patient. An exclusive diet of flesh of animals, fowls and fish is also recommended for obesity—setting up a species of starvation, and for dyspeptic ailments, because of its simplicity and freedom from carbohydrate fermentation.

It is necessary for a patient on a meat diet to consume from two to two and a half pounds of the edible portion of average beef or mutton to supply the body with the requisite amount of nutriment to meet the demands of the organism. One pound of beef or mutton freed from bone,

gristle and connective tissue equals 453 grams. Rubner conducted a series of experiments with an exclusive carnivorous diet upon healthy medical students. The alimentation consisted of from 738 to 884 grams of the edible portion of beef. It was prepared with a little butter, onion, salt and pepper. The beverage prescribed was water or aërated water. After being cooked, specimens of the food were analyzed to determine the percentage of protein and fat. The students' digestion was normal in every particular, the feces containing only 1.2 grams of nitrogen or about 7 grams of protein. The nitrogen balance was maintained in a state of equilibrium with a slight gain in weight.

Solntzer conducted experiments with beef and mutton, and Atwater experimented with both beef and fish. The results of some of these experiments recording the nitrogen equilibrium are graphically set forth in the following table from Tibbles(3):

METABOLISM WITH MEAT DIET

Food per Diem	Days	Nitrogen: Grams in Food	Nitrogen: Grams in Urine	Nitrogen: Grams in Feces	Nitrogen: Gain or Loss	Authority
Beef, 884 grams..........	3	48.8	47.2	1.2	0.4	Rubner
" 738 "	3	39.8	37.6	1.1	1.1	Rubner
" 715 "	1	31.9	25.6	4.6	1.7	Solntzer
Mutton, 1,671 grams.....	1	90.9	58.5	5.0	27.4	Solntzer
" 1,336 "	1	56.4	50.5	3.9	2.0	Solntzer
Canned beef, 895 grams....	1	43.9	27.8	7.5	8.6	Solntzer
" mutton, 1643 grams.	1	75.2	65.3	8.6	1.3	Solntzer
Beef 1,200, butter 30, wine 367, beer 1,250 grams....	3	38.5	37.2	1.0	0.3	Atwater
Fish 1,549, butter 50, wine 700, beer 1,250 grams....	3	45.6	44.1	0.9	0.6	Atwater

The value of an exclusive meat diet in the treatment of tuberculosis, obesity, dyspepsia, and gout has already been pointed out, and will be further elaborated upon when these different ailments are discussed. It also has been recommended in chronic dyspepsia, especially in a condition of atony and in dilatation of the stomach, and its value is unquestioned in hyperchlorhydria. The fact must not be lost sight of, however, that sufficient nutriment must be consumed to meet the demand of the body, which will require from two to three pounds of the edible portion daily. The quantity of meat should never be less than six ounces of thoroughly minced meat, slightly cooked, ingested at least three times per day, the intervals being from 4½ to 5 hours.

Salisbury Diet.—The Salisbury diet(12) is a typical meat diet consisting of from 2 to 4 pounds of beef and 3 to 5 pints of hot water daily for from 4 to 12 weeks. It has been recommended as a means of treating certain diseases of the skin, as psoriasis(13), which have resisted the usual forms of medication.

It is also recommended by Dr. Salisbury for the dietetic treatment of gout, obesity, chronic intestinal derangements, and disorders of nutrition which are attributed to abnormal carbohydrate fermentation. The treatment aims at the thorough cleansing of the stomach before eating, by giving a pint of hot water an hour and a half before each meal and at bedtime. If the water is drunk slowly, the patient will not experience any sense of discomfort nor will the stomach become distended. The slightly nauseating taste of plain hot water may be overcome by the addition of ginger, lemon juice or weak tea, and in cases where intense thirst is present, the addition of a little nitrate of potash makes the water a more efficient thirst quencher. If constipation is present, a teaspoonful of magnesium sulphate may be added to the water. The urine should be examined frequently to obtain the specific gravity, and the amount of water should be regulated accordingly. If the specific gravity falls below 1.010, the patient may become asthenic and the amount of water may be considerably reduced. The specific gravity of the urine should be kept between 1.012 and 1.015.

Caultey(14) gives the following directions for the preparation of the Salisbury diet: "The meat is chopped up quite fine with an American chopper, and all gristle, bone, fat and visible connective tissue are removed. It is made into patties, sufficiently firm to hold together, three to stand near it until of a drab color. Salisbury recommends that they in a frying pan, without fat or water, and rapidly heated, first on one side and then on the other. On removal from the fire they are allowed to stand near it until of a drab color. Salisbury recommends that they should be broiled slowly and moderately well. Butter, pepper, salt, Worcestershire sauce, mustard, horseradish, celery salt and lemon juice may be added as condiments. Advocates of this diet have recommended three pounds of rump steak and one of codfish, with six pints of hot water daily, for two weeks. For the next three weeks the hot water is reduced to four pints, and other kinds of meat are allowed, with a little green vegetable and unsweetened rusks. During the next four weeks the hot water is further reduced to two pints; hock and claret with seltzer are permitted, as are grilled meat, poultry or game, crusts of stale bread and captains' biscuits. The meat must not be raw and must be quite fresh.

"The hot water should be given in doses of one-half to one pint, four or more times a day, say at 6 and 11 A.M., and 4 and 9 P.M., one or two hours before meals and half an hour before retiring. It should be of a temperature of 110° F. to 150° F. and should be sipped slowly in one-fourth to one-half hour."

There are obvious objections to this diet. It is absolutely unphysiological, being a starvation diet in respect of fat and carbohydrates. The quantity is much too large for most people. It throws a great strain on the organs which have to do with the metabolism of protein, as well as on the organs of excretion. It is essential to be sure that the kidneys are sound before adopting this treatment.

Oysters are a welcome addition to the monotony of a meat diet and may be prepared as follows(15):

Panned Oysters:

Take 6 deep-sea oysters, place them in a colander, and pour cold water over them. Drain for ten minutes. Place the oysters in a very hot iron pan, add salt, pepper, a small piece of butter, and a teaspoonful of meat stock. Cook for a few minutes, and serve the oysters garnished with a thin slice of lemon.

Broiled Oysters:

Take 6 large oysters. Lay them on a board and dry, then season with salt and cayenne pepper. Have a gridiron thoroughly heated, place the oysters on the gridiron and brown them on both sides. Place the oysters on a very warm plate, and pour round them a little heated beef juice and a little melted butter.

Watson(15) considers the Salisbury diet seldom necessary or advisable, but he recommends a modified Salisbury dietary as of great value in some cases of indigestion and chronic auto-intoxication associated with it. His modification of the Salisbury diet given below, while rather low in nitrogenous material, is amply sufficient for the short period of time in which the diet is necessary. Its use exerts a profound improvement in the state of intestinal excretions and a corresponding improvement in the digestion as a whole.

MODIFIED SALISBURY DIET

7 A.M.:

½ pint or more hot water.

Breakfast, 8.30 A.M.:

4 to 6 oz. meat rissoles; 2 Kalari biscuits with a little butter; small cup of very weak tea.

Forenoon Lunch, 11.30 A.M.:

½ pint or more of hot water, flavored with lemon if desired.

Dinner, 1 P.M.:

Breakfastcupful of beef tea with ¼ lb. scraped meat; thin slice of baked bread or dinner toast; half a dozen oysters as above; consommé with custard or consommé with egg, with baked bread or toast.

3 P.M.:

½ pint or more of hot water.

Afternoon Lunch, 4 P.M.:

Breakfastcup of skimmed milk, to which is added a full tablespoonful of Carnine Lefranc or other meat juice; or plain egg flip flavored with cinnamon in place of sugar; unsweetened rusk or crisp biscuits.

6 P.M.:

½ pint hot water.

Supper, 7.30 P.M.:

4 to 6 oz. meat rissoles or mince, followed by an egg jelly in which the sugar is reduced in amount; or a blanc mange made with milk in place of cream.

The above alimentation should be maintained for ten days to a fortnight, after which additions in the form of steamed fish, chicken, green vegetables, malted breads, jellies and fruit may be allowed. The return to ordinary carbohydrate foods must be made gradually.

Zymotherapy.—Zymotherapy is the name given to the treatment of disease by the administration of muscle juice or raw meat. This method of treatment is in contradistinction to the meat or Salisbury diet just described, which includes the entire edible portion of the meat. The raw meat diet is an ancient remedy; in recent times it was first recommended for phthisis, empyema and pyogenic infections by Fuster of Montpellier, in 1865. Richet and Hericourt(16), in a series of experiments carried out in 1889 on tuberculous dogs, determined the value of raw meat and subsequently showed that the benefit was derived from the muscle juice and not from the muscle fiber deprived of its juice by expression. They reported that this method of feeding is not a matter of hyperalimentation, for only 50 to 100 c.c. of the muscle juice is suggested as the daily dosage which was sufficient to cure the dogs, whereas hyperalimentation with the washed muscle fibers exerted no beneficial effects. The juice contained 2½ per cent of protein. "Its administration produces an increase of vigor and muscular power, the proportion of hemoglobin is increased, blood pressure is raised, digestion is improved, weight is increased, and the physical signs of *phthisis pulmonalis* or tuberculosis are abated."

If we accept the theory that tuberculosis is due to an infection in early life through tuberculous cow's milk, it is reasonable then to assume that undercooked or raw meat should enter largely into the diet of young children. Meat juice and raw meat are prescribed in anemia, dyspepsia, neu-

rasthenia, debility, convalescence from typhoid fever, and after hemorrhage.

Hericourt, following the publication of his initial observations(17) on the value of raw meat juice in tuberculous dogs, recently published another paper on the subject, from which we quote the following: "It is probably no exaggeration to say that the raw meat treatment in pulmonary phthisis yields results not approached by any other means at present available." Richet coincides with his associate's observations, and together they undertook researches to determine which constituent in the muscular tissue possesses antagonism to the progress of tuberculosis. After much experimentation they came to the conclusion that the solid constituents of the flesh had no therapeutic action; "tuberculized animals fed on flesh from which the muscle plasma had been expressed, died in approximately the same lapse of time as the control animals who were fed with ordinary food. The deduction drawn from the above experiment is that the agent of raw meat which produces this effect is contained in the muscle plasma, *i.e.,* the meat juice."

The muscle or meat juice must be prepared from perfectly fresh meat, soon after the animal dies and before rigor mortis has set in; the muscle that has undergone rigor mortis loses its glycogen and contains lactic acid and more or less toxic products of decomposition. Hence the juice should be prepared as soon after death as possible. If meat or muscle juice is prepared from commercial or cold storage meat, it is less beneficial, more toxic and possibly infective. The animal whose muscle is to be used should neither be overworked nor underfed before death.

According to Caultey(14): "The meat must be finely minced, wrapped in stout linen, put in a sieve, and subjected to slow pressure. Small household presses will yield about 20 and larger presses 30 to 60 per cent of juice. If one-fourth the weight of sterilized water is added and the meat allowed to stand for an hour or two before compression, more fluid is obtained, but the bulk and the increased decomposition are disadvantages. Presses, mincer and linen should be well boiled or washed in boiling water before use. In hot weather the juice should be collected in a vessel surrounded by ice. Even in winter the juice should be taken at once, because of its liability to decomposition. As it is repulsive to the patient, it should be given in a colored glass or with warm beef tea. Intestinal disorders are due to neglect of some detail in the technique, generally to the impossibility of getting the meat sufficiently fresh, and unless great care is exercised, it is liable to set up alimentary, hepatic or renal troubles.

"The dose should be 9 to 15 ounces daily, with or between meals, in

water, aërated water, or tepid beef tea, with or without salt or sugar. Three to six ounces is sufficient for early cases. If raw meat is given, as much as a pound a day can be ordered, but few patients can take more than one-fourth to one-half pound. Raw meat and muscle juice can be combined in the dietary. No cooked meat should be allowed.

"Possibly the muscle juice contains a substance which is antagonistic to the tubercle bacillus and its toxin, for muscle fibers are not invaded by the organism, and during the course of the disease they waste, perhaps being sacrificed in the defense of the body. More probably the good effects depend on the nutritive value of the fluid as a stimulant of the nervous system or of thyroid activity."

According to Galeotti and Lindermann, raw meat and milk stimulate thyroid activity and they also are of the opinion that the decomposition products of raw meat increase the colloid material of the thyroid. It is known that defective thyroid activity and predisposition to tuberculous affections are apt to follow rapid growth at puberty, infectious diseases, prolonged lactation, sexual excess and alcoholism; in all of which the thyroid secretion is liable to be used up and the gland to atrophy from overstimulation. It is believed that human milk contains some of the internal secretion of the thyroid gland, for iodin can reach the infant through the breast milk. Infantile myxedema is rarely observed until after weaning, and moreover the infant's thyroid gland contains little colloid material.

Caultey, in summing up the advantages of zymotherapy, says: "Improvement in a tuberculous patient fed on raw meat and muscle juice is noticed, (*a*) by increased muscular power, (*b*) by the increased hemoglobin, (*c*) by rise of blood pressure, and (*d*) by better digestion and improvement in the physical signs. In the very young the prognosis varies according to the loss or gain in weight, especially during the first month. The treatment should be continued for a varying period depending upon the extent of the disease and the improvement following its administration. It may be resumed at intervals depending on the condition of health.

FRUIT DIET

The fruitarian diet is an aliment composed exclusively of fruits and nuts. Of late years many experiments in metabolism have shown that it is possible for individuals to maintain a nitrogen equilibrium on such a diet. M. E. Jaffa[1] has thoroughly investigated the fruitarians in Cali-

[1] Professor of Nutrition, Univ. of California. Bul. 132, U. S. Dept. of Agric.

fornia. His reports are interesting and valuable, and from them we have drawn largely in preparing this section.

It is not questioned that an alimentation composed of fruits and nuts is pleasant and agreeable. At the same time, it is, at best, only a low protein diet, rarely containing more than 50 to 60 grams of protein. It is unnecessary to refer to the arguments for and against a low protein dietary, as this subject has already been fully considered. Chittenden and other physiologists have found 50 to 60 grams of protein in the daily food sufficient for physiological needs, and many people have maintained their health and vigor for years on a fruit and nut or other low protein aliment, yet they seldom look rugged or robust. The fruit and nut diet, like the more common vegetarian diet, must be considered of questionable value and unlikely to become popular as a regular method of feeding, with people who have an inborn taste and desire for animal foods.

We have already shown that, as compared with the so-called standard dietaries, the vegetarian and fruitarian are lamentably poor in protein and fat, and in some instances deficient in caloric value. See also the following tables abstracted from the excellent study of Fruitarianism by Professor Jaffa(8). Below are appended the records (taken from Voit and Alba) of three subjects who subsisted on fruits, as recorded by Tibbles:

Man, twenty-eight years old; height, 5 feet 5 inches; weight, 125 pounds. His daily diet consisted of: rye bread (pumpernickel), 131 grams (4½ ounces); graham bread, 438 grams (nearly 1 pound); apples, 777 grams (1¾ pounds); dried figs, 114 grams (4 pounds); dried dates, 247 grams (8 ounces); oranges, 66 grams (2 ounces); olive oil, 21 grams (¾ ounce). It contained: protein, 54 grams; fat, 22 grams; carbohydrates, 573 grams; and had a heat value of 2,775 calories. (Voit's observation.)

Man, forty-eight years old; height, 5 feet 8 inches; weight, 153 pounds. He consumed daily: potatoes, 1,000 grams (2¼ pounds); hazel nuts, 166 grams (6 ounces); peanuts, 12.5 grams (½ ounce); plums, 83 grams (3 ounces); sugar, 71 grams (2½ ounces); raisins, 93 grams (3½ ounces); apples, 354 grams (¾ pound); oranges, 63 grams (2½ ounces); olive oil, 50 grams (1¾ ounces). It contained: protein, 63 grams; fat, 66 grams; carbohydrates, 593 grams; and had a fuel value of 3,302 calories. (Alba's observation.)

The following example of a moderate vegetarian diet is outlined by Jaffa. His subject was a man, aged sixty-four years, height 5 feet 8 inches, weight 136 pounds; he had been a vegetarian for eleven years. The total food consumed by him during a period of twenty-four days was as follows:

JAFFA'S VEGETARIAN DIETARY

Cereals:		Carried forward.....	8,790 grams
Granose..............	2,155 grams	Fresh fruit:	
Gluten flour..........	454 "	Apples................	5,585 "
Flaked rice...........	1,673 "	Bananas...............	2,722 "
Honey..................	1,985 "	Grapes................	3,317 "
Vegetables:		Raspberries...........	397 "
Baked beans..........	1,021 "	Nuts:	
Dried fruits:		Almonds..............	907 "
Dates................	425 "	Brazil nuts...........	1,361 "
Figs..................	28 "	Pine-nuts.............	198 "
Prunes...............	794 "	Walnuts..............	907 "
Raisins...............	255 "		
		Total.............	24,184 grams
	8,790 grams		

These items furnished an average weight of 2¼ pounds of food daily at a cost of 18½ cents, containing: protein, 53.5 grams; fat, 76.9 grams; sugar and starch, 301.8 grams; crude fiber, 10 grams. The fuel value was 2,043 calories. The man was healthy and well, and lived on a dietary containing 50 to 60 grams of protein, or about half the amount commonly accepted as being necessary for a man having a sedentary occupation.

It is unquestioned that a fruit diet in certain diseased conditions is a valuable trophotherapeutic measure. The subject of Professor Jaffa's investigation was a healthy, vigorous university student, aged twenty-two, well set up, and prominent in athletic sports.

For the first week he ate his ordinary mixed food; the next nine days he consumed a diet in which fruit replaced a large proportion of the meat, eggs, fish, milk and cereals; finally he consumed for eight days a diet consisting entirely of fruit and nuts.

An examination of the urine and feces of other consumers showed that in many instances, although the diet was of a low protein character, the amount of protein digested and absorbed from the food was enough to maintain the nitrogen balance in equilibrium during the experiment. When the amount consumed daily consisted of 5½ pounds of grapes, 6 ounces of walnuts, and a little granose, there was an actual gain of 1.29 grams of nitrogen, equal to 8 grams of protein. In another instance the average daily consumption consisted of 4¼ pounds of apples, 8 ounces of dried figs, and 4¾ ounces of walnuts, which also resulted in a gain of 1.28 grams of nitrogen, or 8 grams of protein. With a diet averaging 3½ pounds of apples, 9⅓ ounces of dates, 6 ounces of peanuts, a little granose, milk, olive oil, and tomato, the gain of nitrogen was 2.26 grams, equal to 14.13 grams of protein. With 5½ pounds of pears, 7 ounces of walnuts, a little granose and milk, there was a gain of 4.25 grams of nitrogen, equivalent to 26.5 grams of protein; and with a diet averaging 16 ounces of walnuts, 18½ ounces of dried prunes, and 18 ounces of oranges, there was a gain of 3.42 grams of nitrogen, or 21.38 grams of protein.

The experiments in feeding with bananas did not give such good results. Bananas, dates, and walnuts resulted in a loss of 1.82 grams of nitrogen, or 11.38 grams of protein; bananas, oranges and walnuts gave a deficiency of 1.89 grams of nitrogen, or 11.8 grams of protein. The consumption of 5 pounds of bananas a day resulted in a loss of 1.34 grams of nitrogen, or 8.38 grams of protein; 4 pounds of bananas and 4½ ounces of almonds daily gave a deficiency of 0.86 grams of nitrogen, or 5.38 grams of protein; 2½ pounds of bananas, 21 ounces of oranges and 5 ounces of pecan nuts gave a deficiency of 1.69 grams of nitrogen, or 10.56 grams of protein. A diet of 22 ounces of dates, 2¾ ounces of almonds and 12 ounces of olives gave a deficiency of 2.06 grams of nitrogen, or 12.88 grams of protein. A diet of pears and cocoanut gave a loss of 1.57 grams of nitrogen and 8.8 grams of protein. The deficiency is not great in any of these cases, but the continued daily loss of 1 or 2 grams of nitrogen by the body is deleterious and must ultimately result in ill health. It is possible, as we have seen, to prevent such a loss by means of a carefully regulated diet; but it is difficult for the non-scientific subject to adjust his diet so carefully to the needs of the body. In this respect, therefore, we are bound to state that very few fruitarian diets contain enough protein to maintain the nitrogen balance in equilibrium, and still fewer contain the amount of protein required by the standards set up by numerous authorities. The amount of fat in the food is also almost always below the standard required, and only reaches the standard when the food contains a large proportion of nuts, olives or olive oil. The nutriment in fruit consists chiefly of carbohydrates, the digestibility of which compares very favorably with the carbohydrates in a mixed diet. Respecting the heat value of the food, the following table shows that the amount of energy yielded by the food is greater in proportion to the amount of fat; it is low with bananas, but better when bananas and nuts are consumed together; it is also low with apples, pears or grapes as a diet, but is considerably improved by the consumption of half a pound of brazil nuts, pecans or walnuts. A diet of apples, figs and walnuts, or of pears, figs and walnuts, is capable of supplying enough protein, fat and carbohydrate for the use of the body, and sufficient energy for a man doing moderate work.

Carefully recorded studies of persons subsisting upon fruits and nuts are scarce; therefore, the observations of Jaffa(18) are of special interest. The instructive table on page 544 contains a summary of the food elements contained in the dietary which each individual, described by Jaffa, ate.

The first six of these people lived on apples, dates, figs, peaches, apricots, bananas, grapes, oranges, pears, plums, raisins, olives, almonds, pignolia, pine nuts, brazil nuts, walnuts, sometimes tomatoes, celery and honey.

The individuals comprising the subjects for Jaffa's studies were all vigorous and healthy people. The six-year-old girl had subsisted on a fruit diet since infancy. She was undersized, but this may have been from inheritance. During the ten days that she was under observation she gained

FRUITARIANS STUDIED BY JAFFA

	Age in Years	Weight in Pounds	Protein: Grams	Fat: Grams	Carbo-hydrate: Grams	Crude Fiber: Grams	Calories
Woman	33	90	33	59	110	40	1,300
Woman	30	104	25	57	72	27	1,040
Girl	13	75.5	26	52	111	46	1,235
Boy	9	43	27	56	102	50	1,255
Girl	6	30.5	24	58	97	37	1,190
Girl	7	34	40	72	126	8	1,385
Man	63	124	40.3	53.7	286.3	24.6	1,713
Woman	64	136	53.5	76.9	301.8	10	2,043
Boy	10	58	48.4	67.7	246.7	13.4	1,729
Girl	8	37	32.3	81.7	155	10.7	1,403
Woman	34	93.5	42.5	81.1	156.8	9.8	1,432
Man	22	170	85	158.7	366.3	....	2,936
Man	25	152	68	103	550.1	64.7	3,305
Man	48	153	63	98	401	....	2,493
Man	28	125	54	22	573	....	2,775
Man	64	136	54	77	312	....	2,004

a pound, and her brother, aged nine, gained a pound in a period of twenty-two days. The thoroughness of digestion and absorption was comparable with that of an adult on a mixed diet, 80 per cent of the fibrous cellulose being completely digested. The fourth study of this table was a boy aged nine, who first subsisted on bananas, oranges and pecan nuts. This same boy was studied a few months later, and during the observation he subsisted on pears and walnuts, granose and milk. Some of the other persons in this study ate cereals to a limited extent. The twelfth individual subsisted on grapes, brazil nuts, tomatoes, granose and olive oil. He was not accustomed to a fruitarian diet, but tried it at the time of the experiment. A striking feature of these fruitarian dietaries is the small amount of protein and the low caloric value of the diets. However, they approach very closely to what Chittenden has shown is all that is needed to maintain health and strength.

Fruit Diet in Disease.—The value of a fruit diet is especially marked when employed as a temporary measure in those instances of illness or poor health in which the protein intake must be diminished, particularly when the necessity arises for cutting down the purin bodies to the lowest possible point. When the ordinary diet is confined to fruits and nuts, the latter should be ground in a mill, mastication should be thorough, only a moderate quantity of food should be allowed, and the daily meals should

not exceed three. The best subjects for the "fruit cure" are those who habitually overindulge in food and drink, and whose systems become choked with the "clinkers" of imperfectly oxidized food. Symptoms commonly complained of in this condition are a foul tasting mouth after the night's sleep, early morning headache and lassitude. This cure is often useful in intestinal fermentation and putrefaction; in albuminuria, gout, obesity, hemicrania, and other disturbances common to individuals and families originally accustomed to plain and wholesome country living. The attempt of an organism with such a background to adapt itself to the modern demands of city life, often results in disaster to the bodily mechanism. The "fruit cure" in such instances is often beneficial. The low protein intake allows an increased alkalinity of the blood and decreased acidity of the urine; in addition, its action is laxative and diuretic, and the liver cells are stimulated to greater activity, and hinders intestinal fermentation. In the dietetic treatment of acute nephritis, fruits, such as oranges, raisins, pears, etc., will augment the carbohydrates of the milk. This mixed treatment of milk and fruits diminishes the albuminuria, encourages diuresis, and drives away edema. If a patient has lost weight, raisins or raisin juice, added to a diet rich in fat and albumin, will help to regain the loss. If, on the other hand, it is thought wise to decrease the patient's weight, increase the raisins and decrease the fats and albuminoids, other fruits and vegetables being partaken of at the same time. The fruit diet is useful when occasionally it is thought wise to institute a fast day, when the only food should consist of apples, grapes, pears, bananas, or some other variety of fruit.

In some sections, "apple-fasts" have been very popular with many persons, especially society matrons who have become "fair, fat and forty" and are anxious to reduce their weight. They are also recommended in gouty diathesis, chronic rheumatism and chronic disturbances of the liver, Bright's disease, and in the condition of high blood pressure preceding the development of arteriosclerosis, and in intestinal fermentations and putrefaction, etc. "Fasts" on apples alone do not agree with all patients, and there are some individuals who believe they cannot abstain from their ordinary dietary for a period of twenty-four hours, even though they may consume large quantities of fruit.

The partaking of fruit in acute febrile conditions is a very ancient practice. Fruits such as grapes, strawberries, oranges, bananas and baked apples may be taken with impunity in many febrile affections. When studying the various fruits we learned that the fruit juices are of considerable dietetic value in the treatment of diseases. The trophotherapeutic

action of fruit juices increases the secretion of urine and its alkalinity, and stimulates the kidneys and indirectly the skin; at the same time these juices act as thirst quenchers. The juices of grapes, oranges, pineapples, currants, gooseberries, raspberries and strawberries are freely used for this purpose. The juice of the lemon is one of the commonest articles in the sick room in the form of lemonade. The many recipes for its use in the sick room will be found elsewhere in this volume.[1] The juice of the orange is also as useful in illness as it is palatable in health. Various recipes for using orange juice will also be found in the reference just cited.

LEMON CURE.—The "lemon cure" is a very ancient practice in the treatment of obesity and the gouty diathesis and is highly recommended when combined with thermotherapy. The usual method is to take the expressed juice of three fresh lemons in sweetened water three times a day with the exclusion of milk and fatty foods. Preserved lemon juice is not as effective as that of the fresh fruit. It is questionable, however, if there is any scientific basis for the consumption of lemon juice as an anti-fat. The manufacturer of quack remedies for obesity uses a large percentage of citric acid in his remedies which are practically worthless. The effect of lemon juice upon the food seems to exert an inhibitory power over steapsin and amylopsin, which retards the digestion of fat and carbohydrates.

GRAPE CURE.—Ampelotherapy, or "grape cure," is probably the best known of the fruit cures. It is usually carried out in southern Europe at places like Meran and Montreux, but is available wherever grapes can be obtained. The grape cure depends largely for its good effects on change of diet and manner of life, the climate and surroundings, and the aperient action of the grapes. When aided by a simple supporting aliment, it is a suitable dietary for the overworked, the weak and the convalescent. It is recommended in conjunction with the spare diet limited particularly as to hydrocarbons and carbohydrates, in cases of abdominal plethora, chronic bronchitis and emphysema, chronic constipation, and chronic gastro-intestinal catarrh. Its use is also valuable in the dietetic treatment of obesity. When the grape cure is taken in Germany, from one to eight pounds of grapes are eaten daily and little or no other food allowed. Those who take the cure are expected to pick the grapes for themselves, which insures exercise in the open air. This method is particularly adapted to the obese and to those who lead a sedentary life. The treatment ordinarily consists in taking one pound or more of grapes three

[1] Volume II, Chapter XVII, page 579.

times daily from half to one hour before meals, the meals consisting of light, easily digested foodstuffs, for example, fish, chicken, milk puddings, stewed fruit, toasts or rusks, and green vegetables, avoiding all rich made dishes, rich sauces, pickles, potatoes, lentils, pastry, cheese and sweets. The duration of the course is from four to six weeks. The chief effect of this alimentation is a laxative one, which renders it suitable in hepatic ailments, chronic constipation and hemorrhoids. For the analysis of grapes, see Volume I, Chapter XIX, page 752.

Caultey(14) recommends the following mode of treatment: "Begin with half a pound of grapes when fasting, an hour or two after a light breakfast, and again at 5 P.M. In three days give a third half-pound at noon, or after the midday meal if there is dyspepsia. Gradually increase the dose to one pound at a time. The aperient effects are manifest in a few days. It is rarely advisable to give more than two pounds in lung cases; three pounds in gastric and intestinal catarrh, the diet being carefully regulated at the same time; and four pounds in other conditions; but the amount may be increased to five to six pounds for abdominal plethora, hepatic constipation and chronic constipation. Figs and prunes can be added to relieve the monotony of the diet. The course of treatment lasts for six weeks. Small quantities of white bread may be eaten after the grapes to remove acids from the teeth, and if the gums become irritated, the mouth should be rinsed out with bicarbonate of soda solution."

TUFNELL AND BELLINGHAM DIETS

Tufnell's diet for the treatment of aortic and other aneurisms is a modification of the methods formerly employed by Albertini and Valsalva(19) in cases which could not be treated surgically. The plan of treatment was to "detain the patient in bed for forty days, and during this period to subject him to repeated bleedings, while at the same time the diet and drink were carefully ordered, so that the daily allowance administered in three or four meals should never be such as to fill up the blood vessels. The practice formerly was to diminish the quantity of meat and drink gradually every day, until it was cut down to about half a pound of pudding in the morning and in the evening half that quantity and nothing else except water, and this also within a certain measure. After having sufficiently reduced the patient by this method so that by reason of weakness he could scarcely raise his head from the bed in which he lay, the quantity of aliment was increased again by degrees until the necessary strength returned sufficiently to allow him to rise in bed."

Bellingham in 1852 omitted the blood-letting and devised a method which was continued by Tufnell, who in 1875 published a monograph on the subject, the principal aim being the reduction of the force and frequency of the heart's action and to favor the deposition of fibrin on the wall of the aneurismal sac. The treatment is very debilitating and "only suitable for cases of saccular aneurism unassociated with disease of the aortic valve, and for patients who are sufficiently intelligent to understand the importance of carrying it out strictly and who have sufficient will power to put up with its discomforts."

Bellingham's dietary is very much the same as Tufnell's, both of which are given below. They are modifications of the methods adopted by Albertini and Valsalva, who treated their patients by bloodletting, rest and modified diet.

	Bellingham		Tufnell	
Breakfast	Milk or tea	2 oz.	Milk or cocoa	2 oz.
	Bread	2 oz.	Bread and butter	2 oz.
Dinner	Liquid	2–4 oz.	Water or light claret	4 oz.
	Bread	1–2 oz.	Bread or potato	3 oz.
	Meat	1–2 oz.	Boiled or broiled meat	3 oz.
Supper	Liquid	2 oz.	Milk or tea	2 oz.
	Solid	2 oz.	Bread and butter	2 oz.

Tufnell's diet contains eight ounces of fluid and ten ounces of solids. It is true that this dietary, or one quite similar, though not so severe, has often modified pain or caused it to disappear entirely, while the aneurism has become smaller and pulsated less; but many patients refer to the cure as worse than the disease. The method of treatment as outlined by Caultey(14) directs that the "patient should rest on a water bed and remain absolutely still, doing nothing whatever for himself, a restriction which few people have the strength of will to adhere to. The mouth may become so dry and parched that even the limited amount of solids cannot be taken. Sucking a pebble or button will relieve the thirst a little. Another great trial to the patient is painful micturition, because of the extreme acidity of the urine. It can be reduced by alkalies. Constipation must be relieved by oil enemata if necessary. There is so little waste matter in the food that an action of the bowels once a week is sufficient. The heart and aneurism must be carefully watched. If the pulse becomes more and more frequent, the patient restless, and the dryness of the mouth so great that he is unable to take food, the treatment must be modified."

Such a restricted diet is no longer believed by able clinicians to be

essential to good treatment, while an abstemious, nutritious diet is. This starvation treatment is only advisable in well-nourished subjects, especially those with a plethoric temperament. It is, on the other hand, altogether unsuitable in weak or debilitated subjects. In the latter class there is more often than not an enfeebled digestion and it may be advisable in the beginning to resort to a milk or lacto-vegetarian dietary. Rest in bed or in mild cases gentle exercise should be insisted upon. To-day the iodids are almost universally relied upon. In recent years the subcutaneous or intravenous injection of gelatin has been used with some success. Of course, the gelatin should be sterilized and the strictest care taken to prevent sepsis.

The important points to keep in mind in prescribing a dietary in all cases are, according to Watson(15), the following:

(*a*) Restriction in the amount of fluids of all kinds. Not more than from 20 to 30 ounces in the twenty-four hours.

(*b*) Meats and meat foods to be given in very sparing amount, the stimulating effects of these foods on the circulation being prejudicial.

(*c*) A light, simple, nutritious diet, given thrice daily, with no food between meals. The meals should be much on the lines of the diet laid down on page 548.

(*d*) Alcohol in all its forms is inadvisable, excepting in cases of feeble digestion, where its use in small doses may prove beneficial.

WEIR MITCHELL DIET

The Weir Mitchell diet(20) is recommended by the author for the dietetic treatment of neurasthenia and disorders of malnutrition independent of organic disease. The principal points in carrying out this method of treatment are isolation, massage and forced feeding. The isolation from friends, callers and the family exerts a beneficial and moral effect. Massage and electricity aid in promoting digestion and the nutrition of the muscles. A good nurse is essential. She must be kind, bright, sensible, and able to make a favorable impression on the patient.

The patient should be kept in bed for at least six weeks, leaving it only to go to the toilet. Mitchell recommends that the milk diet should be instituted gradually, especially if the patient has an aversion for milk. It should be given in doses of one or two ounces every two hours and gradually increased until as much as two quarts are drunk in the twenty-four hours. In some cases Mitchell recommends that the milk should be given even at night as often as every three or four hours. At the end of the tenth day an egg or chop should be eaten at noon in addition to the usual allowance of milk. Often earlier than this Mitchell prescribes

meat juice once or twice a day. A day or two later bread and butter are given and an egg or some meat at breakfast as well as at dinner. By degrees the patient is placed upon a diet of three simple but generous meals daily, and in addition, three or four pints of milk are consumed, the latter being administered partly with the meals and partly between meals.

The following is a synopsis of the management of an individual case of Weir Mitchell's and is appended to illustrate the practical application of his rest cure:

WEIR MITCHELL'S DIETARY

Mrs. C., kept in bed, fed by an attendant, rise only to relieve bladder and rectum.

First Day: One quart of milk in divided doses every three hours.

Second Day: Cup of coffee on awakening. Two quarts of milk in divided doses every two hours. Aloetic pill at night.

Third to Sixth Day: Same diet.

Seventh, Eighth, and Ninth Days: Same diet, with a pint of raw soup in three portions. This is made by chopping up one pound of raw beef and placing it in a bottle with a pint of water and five drops of strong hydrochloric acid. The mixture stands in ice all night; in the morning the bottle is put into a pan of water at 110° F., and kept two hours at about that temperature. This mixture is then thrown into a stout cloth and strained until the mass that remains is nearly dry. If the raw taste proves very objectionable, the beef to be used is first quickly broiled on one side and then the process is completed in the manner previously described.

Tenth Day: 7 A.M., Coffee; 7.30 A.M., 10 A.M., 12 M., 2, 4, 6, 8, 10 P.M., Half a pint of milk; 11 A.M., 5 and 9 P.M., Soup.

Fourteenth Day: Eggs, and bread and butter added.

Sixteenth Day: Dinner added and iron.

Nineteenth Day: The entire diet was as follows: 7 A.M., Coffee; *Breakfast,* 8 A.M., Iron and malt extract, chop, bread and butter, a tumbler and a half of milk; *Lunch,* 11 A.M., Soup; *Dinner,* 2 P.M., Anything liked, with six ounces of Burgundy or dry champagne, and at the end one or two tumblers of milk. Iron and malt; *Tea,* 4 P.M., Soup; *Supper,* 7 P.M., Malt, iron, bread and butter, usually some fruit, and two glasses of milk; *Late Supper,* 9 P.M., Soup; 10 P.M., Aloetic pill. At 12 noon, massage for an hour. At 4.30 P.M., electricity applied for an hour.

Sixth Week: Soup and wine were dropped, iron lessened one-half; massage and electricity only on alternate days; 1/30 of a grain of strychnin sulphate thrice a day at meals given (continued for several months).

Ninth Week: Milk reduced to a quart. All mechanical treatment ceased.

RESULT: Gain in flesh about face in second week. Weight rose in two months from 96 to 136 pounds; gain in color equally marked. On thirtieth day patient had normal catamenial flow after five years of failure to menstruate. Ninth week, drove out. Cure complete and permanent.

By the end of the sixth week of this treatment, the patient may be returned to a full diet and in addition take at least from 60 to 80 ounces of milk per day.

FULL NEURASTHENIA DIETARY (Weir Mitchell)

Early Breakfast, 7 A.M.:
 10 ounces of milk.

Breakfast, 8.30 A.M.:
 Plate of porridge or gruel, or hominy; or bowl of bread and milk with a gill of cream; fish, bacon, eggs, or kidney; cocoa or coffee; bread or rolls; butter or marmalade.

Lunch, 9 A.M.:
 10 ounces of milk.

Second Lunch, 11 A.M.:
 Cup of beef tea with 2 teaspoonfuls of beef peptonoids.

Dinner, 1.30 P.M.:
 Fish, tripe, sweetbread, cutlets, game or poultry, served with one vegetable, with a sweet such as stewed fruit; 10 ounces of milk to be sipped slowly during this meal.

Afternoon Lunch, 4 P.M.:
 10 ounces of milk with sponge cake; bread and butter, or rusk.

Supper, 6.30 P.M.:
 A three-course meal. Soup or fish; joint or poultry; sweet or savory, or dessert; taking with meal 10 ounces of milk.

Late Supper, 8.30 P.M.:
 Beef tea and 2 teaspoonfuls of peptonoids.

10 P.M.:
 10 ounces of milk.

Occasionally a physician is called upon to attend a stout patient with flabby muscles presenting the usual symptoms of neurasthenia. In the successful handling of this type of patients, a mild starvation is a necessary preliminary for a few days prior to beginning the Weir Mitchell treatment. This method of treatment is recommended by Playfair as follows:

Confine patient strictly to bed; diet with skimmed milk, at first two quarts per diem, given in small quantities every two hours; after a day or two lessen this gradually till not more than a pint per diem is taken. If the patient's strength fail unduly under this, some beef tea or soup may be temporarily substituted for the milk. Under the minimum diet the weight gradually loses about ½ pound per diem (the patient should be weighed every second day), and when some 14 to 20 pounds have been taken off, pure milk may be substituted for skimmed, and the treatment as detailed above pursued.

TRAINING DIET

The training diet is a question which has been agitated during recent years by the leaders in field athletics at the greater schools and universities both of this country and Europe(21). Of late, a great deal has been written pertaining to the diet best adapted for athletes, both amateur and professional, when training for a contest, in order to have them physically fit for feats of endurance. The necessity of this training is fully recognized by all athletes, and while opinions may differ as to the methods, there is more or less accord in the ideal that is sought. The object of training is to put a man in condition to execute a large amount of work, and sometimes skilled work, in a very short period of time, which is quite a different problem from feeding a laborer or artisan. The latter requires an alimentation which will enable him to do a large amount of work daily, continuing over a long period of time.

The usual training diet has been based on a liberal allowance of meat, on the assumption that the wear and tear of muscular tissue is great and that meat is the greatest source of strength and less fattening than other foods. The great nervous and muscular energy of carnivorous animals is often quoted to substantiate this assumption. We know that the race horse is the fastest animal for a reasonable distance, but certain species of the carnivora can maintain a short burst of speed which will exceed that of the race horse. It is not questioned that a liberal supply of animal food is suitable for a short distance runner, but it certainly is not a suitable diet for prolonged exertion, as may be seen in the case of the Japanese, who on a vegetable diet are able to run continuously for hours at a time and drag a jinrikisha occupied by a passenger.

The general principles of training are: (*a*) the reduction of weight by the removal of superfluous fat; (*b*) the improvement of the tone of the muscles and heart, inducing long "wind" and endurance. During the period of preparation for an athletic test, muscles must be made to grow and the waste caused by trial tests of strength be repaired. Proteins are necessary for cell growth and repair, as well as to furnish nervous energy.

Although carbohydrates are an economical source of a large number of calories or units of energy, so that muscular work can be performed on such a diet, nevertheless rapid and accurate muscular work, that entailing correct correlation of movements, demands much nervous energy, and for this type of work proteins are necessary. Under conditions requiring the ingestion of large quantities of food, a generous proportion of proteins should be furnished on account of their ease of digestion. The

carbohydrate intake should be carefully chosen and skillfully prepared, so that this part of the diet may also be easily digested. Professional athletes recognize the importance of keeping "fit" and being in perfect trim in order to perform feats of strength and endurance. In a well-trained athlete the muscles are hard and firm, the fat is reduced to a minimum, the skin is clear, the eyes bright, the expression indicative of perfect health, the body is active and the "wind" good.

The length of time necessary to train varies with the previous habits and mode of life of the individual. Ordinarily, the average college youth of the athletic type can be put in fit condition in six weeks, and it must be borne in mind that the transition from ordinary habits to those of training should be gradual both as to the regulation of the alimentation and of exercise.

Practice and experience have emphasized the advisability of a generous mixed, liberal, full diet as the one calculated to put an athlete in the best trim. At the training tables of the Harvard and Yale crews such food as the following is eaten: Good lean beef or mutton, best given underdone, toast made from stale bread, and potatoes and green vegetables of all kinds. Fruits, beef, lamb, mutton, chicken, fish, bacon and eggs, and simple puddings are allowed, but no highly seasoned food is permitted(22). The following articles are prohibited: entrées, rich puddings, pastries, sauces, pickles, spices, appetizers, and all fancy and complex dishes. Made dishes or dishes made from twice-cooked meats, all spirits and strong alcoholic drinks, as well as tea, coffee and nerve stimulants are prohibited. Tobacco, in all forms, is strictly forbidden. Water is allowed in liberal quantities, but if there is a tendency to obesity, the amount is somewhat limited, the quantity being gradually reduced and only sufficient quantity allowed to allay thirst. We have already referred to carbohydrates as producers of strength. In this connection it is interesting to note the experiences of the Holland oarsmen, who, according to Davis(23), "while in training began to show signs of overwork, loss of flesh, a lack of ambition and energy, and a disinclination for study and work. By eating sugar as freely as they wished, sometimes as much as one-third of a pound a day, they were refreshed and able to win the race against the antagonists who did not believe in its use." Sugar, a crystallized carbohydrate, is permitted as an adjunct to the dietary of the athlete in training, but pies, cakes and other sweets and more or less indigestible dishes, as already pointed out, should be forbidden(24).

Atwater and Bryant(25) conducted experiments on this particular question, from which we cite the following:

Two young men, with only two hours a day for practice, at the end of two months entered for the race. No change had been made from their usual diet, except that they ate as much sugar as they wished, sometimes as much as a third of a pound at the time of their daily exercise. One of them, however, did not make this addition to his diet until the third week, when he began to show all the signs of overtraining—loss of weight and a heavy, dull feeling, with no desire for study. On the third day after beginning the use of sugar these symptoms disappeared. At the time of the race both youths were victorious over their antagonists, who did not believe in the use of sugar. No bad effects were observed.

An athlete in training must ingest more food and in larger amounts than a person of the same physique following an ordinary vocation, but care must be taken not to overeat and thereby derange digestion; nor must the meals be eaten at too long intervals.

The following report of the Yale crew, on the authority of Dr. Hartwell, formerly a captain of the University crew and of the University football team, is quoted from Thompson(26):

The training covered a period of ten and one-half weeks.

DIETARY, YALE TRAINING CREW

Breakfast, 7.30 A.M.:

Fruits (oranges, tamarinds, figs, and grapes); cereals with rich milk and sugar, etc.; beefsteak, usually rare; chops, stews, hash, with once or twice a week some salt meat, as bacon or ham, usually accompanied by liver; stewed, browned, or baked potatoes; eggs served in different ways; oatmeal-water and milk as beverage, with tea on special occasions for some particular individual.

Dinner, 1 P.M.:

Soups, meats, fish, vegetables, with a simple dessert, such as rice, bread, or tapioca pudding, some fruit, and the same beverages as at breakfast were also used. The meats included roast beef, mutton, or chicken, two kinds being always served. But little gravy was used. Fish was served twice a week. The vegetables included potatoes, mashed or boiled; tomatoes, peas, beans, and corn. Two vegetables besides potatoes were usually served.

Supper, 8 to 8.15 P.M.:

Cereals, as at breakfast; chops, stews, or cold meat from dinner; rarely beefsteak; potatoes, stewed or baked; and eggs about three times a week, usually not on the same days that they were served for breakfast. Sometimes ale was permitted to some individual.

After the crews were in final preparation for the race at New London the diet varied somewhat: Breakfast and dinner remained about the same, but a light luncheon of cold meat, stewed or baked potatoes, milk and toast was served at 4.30 in the afternoon. After this the evening exercise was engaged in for about two hours. Forty-five minutes after this was completed cold oatmeal or other cereal with milk and toast was served. A light supper was served at 9.30, just before the men retired. This diet was much more liberal than that served ten years before. The men were allowed as much food as they desired.

The table of dietary studies incorporated herewith is taken from the extensive studies of Atwater and Bryant, giving the summary of results of dietary studies of university boat crews, football teams, and of professional athletes, and compares them with the standard dietaries of men engaged in various occupations.

DIETARY STUDIES OF UNIVERSITY BOAT CREWS
NUTRIENTS ACTUALLY EATEN PER MAN PER DAY

Crews	Protein, grams	Fat, grams	Carbohydrates grams	Calories
Harvard University Crew	162	175	449	4,130
Harvard Freshman Crew	153	223	468	4,620
Yale University Crew	145	170	375	3,705
Harvard University Crew (Gales Ferry)	160	170	448	4,075
Harvard Freshman Crew (Gales Ferry)	135	152	416	3,675
Yale University Crew (Gales Ferry)	171	171	434	4,070
Captain Harvard Freshman Crew	155	181	487	4,315
Average	155	177	440	4,085

It is interesting to note that these dietaries for the university crews are very similar to that advised for Americans during a period of hard work. They are a little fuller than the English and German standards. Football teams lead in the quantity of food ingested. Relative to the other carbonaceous foods, the proportion of protein is markedly increased. Comparing the dietary of college students in training with that of an ordinary college club, the excess of proteins in the former is very noticeable. The average diet of a training crew contains 155 grams of protein and yields 4,085 calories, making a difference in fuel energy between the two of about 400 calories. The diet furnished the oarsmen at Gales Ferry yielded the oarsmen one-ninth more energy than that of the men not engaged in athletic work. In other terms the difference amounted to 48 grams or an increase of nearly one-half of protein.

Atwater and Bryant(27) outlined the following account of the dietary of the Harvard boat crew at Cambridge:

The diet was simple, and consisted of roast and broiled beef and lamb, fricasseed chicken, roast turkey and broiled fish. Eggs, raw, poached or boiled in the shell, were used plentifully. Large amounts of milk and cream were also consumed. Oatmeal, hominy and shredded wheat were eaten extensively, and corn cakes were served occasionally. Bread was almost always taken in the form of dry toast. Potatoes were served twice a day, either baked or boiled and mashed, with the addition of a little milk and butter; occasionally they were creamed. Boiled rice, prepared with a little cream and sugar, was served instead

of potatoes at some meals. Beets, parsnips, green peas and tomatoes were used to furnish a variety of vegetables. Macaroni was occasionally served. For dessert, apple, tapioca, custard, or other pudding containing a large proportion of milk and eggs, was served. The members of the crew were allowed beer once a day. Milk was obtained from one of the large creameries supplying that vicinity, and was of unusually good quality, containing 5.8 per cent of butter fat. A very thick, heavy cream was also used, diluted about one-half with milk. This mixture, or thin cream, contained about 16 per cent of butter fat.

The animal food consumed during this study was entirely from the loin of the beef. Occasionally the roasts were from the fillet, and at other times the ordinary loin roast with the bone was used. The meat was sliced in liberal portions, being previously practically freed from all the clear fat and tissue, and sent to the table on a large platter from which the men were served individually. The beef was cooked underdone and served rare. When the beefsteak was served, it was freed from the bone, nearly all of the visible fat being removed. Lamb chops were served with the bone. Lamb and mutton roasts were all taken from the leg, and were also clear meat, trimmed free from visible fat. The turkey used was shipped from a distance and had been in cold storage. It was baked with stuffing and dressing, although very little of the latter was served to the crew. Chicken was always prepared fricasseed and served free from bone, except the leg and wing. Fish was usually served for breakfast, bluefish and Spanish mackerel, broiled. Eggs, either raw or poached, were also allowed. No pastry was permitted, and puddings, as previously stated, were composed largely of eggs and milk. No fresh fruit except oranges for breakfast was permitted. Stewed prunes, rhubarb, or apples were eaten most abundantly. No beverages other than water or beer were allowed.

Yeo(28) gives the dietary of the English boat crews at Oxford and Cambridge. It may be interesting in this connection to compare the

A DAY'S TRAINING FOR THE SUMMER RACES

	Oxford	Cambridge
7 A.M.:	Rice; a short walk or run.	A run of 200 yards as fast as possible.
Breakfast, 8.30 A.M.:	Underdone meat; crust of bread or dry toast; tea (as little as possible).	Underdone meat; dry toast; tea, 2 cups (later only 1½); water-cress (occasionally).
Dinner, 2 P.M.:	Meat (as at breakfast); bread; no vegetables (not strictly adhered to); 1 pint of beer.	Meat (as at breakfast); bread, potatoes, and greens; 1 pint of beer. Dessert: oranges, biscuit, or figs; 2 glasses of wine.
5 or 5.30 P.M.	Rowing exercise.	Rowing exercise.
Supper, 8.30 or 9 P.M.	Cold meat or bread; sometimes jelly or water-cress; 1 pint of beer.	Cold meat; bread; lettuce or water-cress; 1 pint of beer.
10 P.M.:	Retire to bed.	

A DAY'S TRAINING FOR THE WINTER RACES

Oxford	Cambridge
7.30 A.M.: Rice. A short walk or run.	7 A.M.: Exercise as for summer races.
Breakfast, 9 A.M.: As in summer.	*Breakfast*, 8.30 A.M.: As in summer.
Luncheon, 1 P.M.: Bread or a sandwich and ½ pint of beer.	A little cold meat; bread and ½ pint of beer, or biscuit and glass of sherry (sometimes yolk of egg in the sherry).
2 P.M.: Rowing exercise.	Rowing exercise.
Dinner, 5 P.M.: Meat as in summer; bread; same rule as in summer as to vegetables; rice pudding or jelly; ½ pint of beer.	*Dinner*, 5 to 6 P.M.: As in summer.
10 P.M.: Retire to bed. Water strictly forbidden. As little liquid to be drunk as possible.	

English dietaries with the dietaries at Yale and Harvard. Maclaren gives the following schemes of training as carried out at Oxford and Cambridge:

In making a résumé of the results of their observations, Atwater and Bryant state that, in a "general way, the difference between the food of the athletes and that of other people represents a difference in actual physical need even if neither is an accurate measure of that need." The principal difference in the food of athletes as compared with that consumed by ordinary working people or college men is that the dietary of the former, owing to the large percentage of protein, is productive of a larger amount of energy. An increase of protein is necessary, not so much to provide additional energy as to make good the wear and tear of the strain on muscular tissue expended in the performance of strenuous exercise or laborious work, as well as in certain cases to enable the muscle to add substance to its bulk. The daily excess of the athletic diet over ordinary diet is about 400 calories or 10 per cent. The amount of protein consumed in the Atwater experiments was about 45 per cent above standard dietaries. "In other words, the difference in protein was four and one-half times as great as the difference in fuel value, and the excess in protein would account for a considerable part of the excess of energy of the diet of the athletes as compared with men in ordinary occupation."

In the final summing up of their research and experiments, Atwater and Bryant record the following interesting observations:

In this connection it is interesting to observe that many physiologists are coming to entertain the view that the amount of metabolism in the body is regulated not simply by the muscular work, but also by the nervous effort required in the performance of this work. The especially large proportion of protein observed in the dietary studies of the university boat crews, of football teams, of the professional athlete and of the pugilist, as compared with the dietary studies of college men with ordinary exercise, and with ordinary families of workingmen and professional men, accords well with a view not uncommon of late among physiologists. According to this view, men who perform continued muscular labor, even if it is active enough to make the total amount large, do not require especially large amounts of protein in their food so long as they undergo no especial mental strain or muscular fatigue, the principal requirements being an abundant supply of easily digested food material. On the contrary, when a man or animal must perform intense muscular work for a short period of time, and is, therefore, under more or less nervous as well as muscular strain, a considerably larger supply of protein seems to be required than under normal conditions of slow, long-continued work. In other words, if a large amount of work must be done in a short time, a considerable excess of protein is required in the food. This view, which has been especially advocated by Zuntz(29), seems to be favored by the results of dietary studies above discussed.

Recent experiments made by Dunlop, Paton, Stockman and Macadam(30) have to do with the amount of protein required when severe muscular work is performed. The results are discussed with especial reference to training, and are believed to "show the importance of two points long known to athletes and others doing excessive muscular work."

The one is the importance of proper training, for by it an abstraction of protein matter from tissues other than muscle can be avoided; the other is the importance of there being a sufficiency of protein in the diet to compensate for the loss which occurs. An abundance of protein in the diet of an athlete has other functions to fulfill besides this. It is required during training for building up the energy-liberating mechanism—the protoplasm of muscle; and it is also required after work to repair that mechanism. The benefits of training are well known in other ways, such as preparing the heart for suddenly increased duty and limiting the after fatigue effects.

The power of the body to perform the maximum of muscular work within a comparatively short time and with a minimum amount of fatigue is secured by means of training. Of course, skill in application of muscular strength is as essential as is the amount of power exerted. The skill is sought by exercise and practice. The object of regulating the diet in training is not only to furnish the material to supply the power, but also to put the machine in the best condition for developing as well as applying the power. In other words, the man is to be subjected for a short time to intense muscular strain and considerable nervous effort. This he is to bear with a maximum of result and the minimum of fatigue. For this he needs practical training, on the one hand, and proper diet, on the other. If the views above presented are correct, the diet for men from whom

intense muscular effort is required for short periods should supply liberal amounts of energy and especially large amounts of protein.

REDUCING DIETARY

A reducing dietary may be so planned that one may dine both well and wisely, omitting the fat-forming foods. Of late, the slim, sylph-like figure has become fashionable, and the physician is daily importuned with: "Doctor, what shall I do to reduce?" When a society matron becomes "fair, fat and forty," she is desperate to reduce and will rigidly adhere to any dietary her physician will outline. Lately both men and women of the first "four hundred" have fasted and fumed, boiled in Turkish baths, and rolled the floor in various gyratory calisthenic contortions, strenuously fighting the tragedy of fat.

We have previously pointed out that everyone, as a rule, and more especially the corpulent individual, eats too much and sleeps too much. In the majority of instances, corpulency is due directly to overeating, and the average dietary consists largely of fat-making foods, from soups to nuts. It follows then that the natural cure for corpulency is to restrict the ingestion of fat-producing foods—carbohydrates and hydrocarbons. Of the former, Mahdah advises the elimination from the dietary of the following: bread, biscuits, crackers, and anything made from wheat, corn, rye, barley, oats, cereals and breakfast foods; rice, macaroni, potatoes and dried legumes; pies, cakes, puddings, pastries and custards; candies, bonbons and all sweets, including ice cream and sirup-sweetened soft drinks. Of the latter class, we would advise the total abstinence from pork, ham, bacon and the fat of any meat; milk, cream, cheese, butter, olive oils and any foods seasoned with grease (Mahdah menus).

At first glance, it would seem that there is little left to eat, but one may dine well and wisely from a menu made up of the following: All kinds of meat except swine flesh; all kinds of game, including fowls; all kinds of sea food, fish, lobsters, clams and oysters; all fresh and dried fruit with the exception of grapes and bananas; all varieties of salad made from fresh vegetables and served with dressings free from olive oil; all types of meat jellies; cucumbers, celery, mushrooms, tomatoes, olives, pickles and chili and Worcestershire sauce. Of green vegetables, any of the following are permissible: Brussels sprouts, string beans, cauliflower, beets, spinach, lettuce, beet-tops and turnip-tops cooked as purées, carrots, squash, celery root, salsify, cabbage, endives, artichokes, radishes, parsnips, eggplant, onions, asparagus (Vance Thompson, Mahdah).

From the foregoing, a menu can be made up that will be satisfying

and contain sufficient food value for healthful maintenance. In Mahdah's "Eat and Grow Thin" [1] will be found menus especially calculated to get rid of excess fat. By following these menus religiously, it is believed that corpulent individuals, without question, lose from fifteen to thirty pounds within a period of three months. It will be noted that these menus do not provide for breakfast. This meal consists largely of fresh or stewed fruit and twice a week boiled or poached eggs may be served; tea or coffee is allowed without cream or milk; other than this, no fluids are to be taken with the meals. Of course, between meals sufficient water to quench thirst may be taken with impunity.

DIET FOR PROFESSIONAL SINGERS AND LECTURERS

Beyond question diet exerts more or less influence on the fullness and richness of the voice. A hearty meal interferes with full, free respiration to the extent that singing is practically or even entirely impossible. The vocal cords may become congested following the ingestion of food or drink, and smoking often exerts an injurious effect upon the voice. Alcoholic drinks imbibed to excess, as well as irritating articles of food, may, and often do, impair the tone of the voice and should be omitted.

Opera singers possess peculiar and curious idiosyncrasies. Certain articles of alimentation exert a deleterious effect upon the voice of some, while the same food will have just the opposite effect on others. Ruhräh(31), quoting Russell in "Representative Actors," delineates an interesting list of foods and beverages partaken of by prominent stage folk prior to appearing before the footlights. He states that "Edmund Kean, Emery and Reeve drank cold water and brandy; John Kemble took opium; Lewis, mulled wine and oysters; Macready was at one time accustomed to eat the lean of a mutton chop previous to going on the stage, but subsequently lived almost exclusively on a vegetarian diet; Oxbury drank tea; Henry Russell ate a boiled egg; W. Smith drank coffee; Braham drank bottled porter; Miss Catley took linseed tea and Madeira; G. F. Cook would drink anything; Henderson used gum arabic and sherry; Incledon drank Madeira; Mrs. Jordan ate calves'-foot jelly and sherry; C. Kean took beef tea; Mrs. Wood sang on draught porter; Harley took nothing during a performance. Malibran, it is said, ate a lunch in his dressing-room half an hour before singing. This consisted of a cutlet and half a bottle of white wine, after which he smoked a cigarette until it was time to appear."

[1] Volume III, Chapter XXVII, "Mahdah's Menus." "Eat and Grow Thin," by Vance Thompson, pub. by E. P. Dutton, N. Y.

While discussing food and drink for actors and their peculiar idiosyncrasies, we will relate the dietary habit of Mr. Edmund Kean, who, according to Smith,[1] "was in the habit of adapting the kind of meat he ate to the part he had to play, choosing pork for tyrants, beef for murderers, and lamb for lovers." This may seem a stretch of the imagination, "but it may indicate that there are subtle differences in the different kinds of meat which chemistry has not enabled us to detect, but which are yet not without influence upon the body."

Ordinarily, no food should be partaken of immediately before singing or speaking, but a good meal should be ingested some three hours before, which should be somewhat lighter than usual. It is the habit of many singers and speakers to refrain from food prior to their performance or lecture, and to partake of a good full meal soon after. According to Ruhräh, the food much used by singers is the so-called "Jenny Lind soup," which is a very bland potion, and does not impair the voice. "It is made of bouillon and sage, to which are added the yolks of two eggs and half a pint of cream before serving; sugar and spices are added according to taste. Many prominent singers suck an orange, while others chew dried plums immediately preceding their performance." During the interval between performances, a singer, like any other professional person, should subsist on a well-balanced general diet, of course avoiding irritating foods. Singers who have a tendency to obesity should follow the dieting and exercise laid down in Volume III, Chapter XII, for the treatment of this condition. Alcoholic liquors and strong beverages do not in any way improve the voice, but on the other hand may exert a deleterious effect, and should therefore be avoided. Light wines and beer in moderation may usually be taken with impunity. They are best avoided, however, as their continual use may possibly lead to the formation of a drinking habit. Many of the best singers are of the opinion that smoking is injurious to the voice; on the other hand, many famous male singers are habitual users of tobacco and are rarely seen without a cigar in their mouth.

THE DRY CURE

The dry cure consists in withholding fluid from the diet, giving less and less each day, until the patient takes the least possible amount that will sustain life. If carried to this extreme, the thirst becomes both intolerable and practically unbearable, and as a result, patients strenuously rebel. It has been found from actual experiment that the minimum

[1] Dr. Smith in his work on Foods.

amount of water, aside from that contained in the food, which patients can bear is about 15 ounces per diem, which should be taken during the intervals between meals. For the relief of the insatiable thirst in these cases, various measures are employed. It is said that shipwrecked sailors in open boats have relieved their thirst by immersing their bodies in salt water. Under ordinary conditions, however, the skin is not capable of absorbing fluid to any appreciable extent, but, on the other hand, immersion in water prevents evaporation from the surface of the body, which to some extent saves a loss in this direction and thereby satiates thirst. Sucking a slice of lemon or drinking water acidulated with a few drops of lemon juice or vinegar is said to allay thirst better than plain water. Barley and oatmeal waters are occasionally used as thirst quenchers.

A dry diet has been extensively tried by German clinicians, especially in cases of gastric dilatation and in chronic effusion in the joints and in peritoneal cavity. Many types of disease are benefited by a temporary restriction in the daily amount of fluids consumed, but it is hardly ever justifiable to resort to the extreme degree recommended by enthusiastic devotees of the *dry cure.* Thompson says that patients in charge of advocates of the dry cure have developed fatal cases of scurvy, as well as cases of fever with a temperature running sometimes as high as 104° F. A temporary restriction in the quantity of fluid is of dietetic value in gastric dilatation, chronic serous effusion, flatulent dyspepsia due to ingestion of sweets, coffee and tea in too large amounts. It is also advisable in some cases of obesity and aneurism to withhold fluids. Consult the Bellingham and Tufnell Dietary, previously outlined (*see* page 547).

The "dry diet cure," says Albu(32), "is as old as the Greeks, but was revived by Schroth in his so-called *semmelkur,* and has achieved some notoriety in Europe, where several 'institutes' have been established for its practice." The alimentation consists of the consumption of five or six dry rolls in the course of a day, while liquids are entirely restricted for a period varying from five to six days. The method is so rigorously dry that many patients find it difficult to endure, saying the "cure is worse than the disease." Boiled vegetables are allowed for dinner, otherwise nothing is given but dried bread. Thirst becomes so extreme after three or four days that the patient is allowed hot wine freely as a thirst quencher, after which the quantity of fluid is again cut down to two glasses a day until the patient is again obliged to have more fluid. Jerguson found Schroth's diet useful in the treatment of plethora and perito-

neal effusions. He observed that abstinence from fluid caused great distress, so he modified the diet by giving from one-third to two-thirds of a pound of lean beef with bread and light red wine. Sweiten found the dry diet useful in the treatment of dilatation of the stomach. Albu(32) found the dry diet valuable in the dietetic treatment of renal and cardiac dropsy. The patient on returning to the accustomed diet must be cautioned to do so with great care, taking food only in very small portions, a very little at a time. A rapid gain in weight will be noted, which is attributed in part to the restoration of water to his tissues. Bartels observed an increase in urea which was greatest immediately after the treatment. The high temperature accompanying this method of treatment is explained by the fact that but little water is evaporated from the lungs and skin, causing the body heat to be retained. As has been suggested, the dry diet cure has in many instances been carried to the verge of starvation with extreme prostration, fever and fatal cases of scurvy, and has little or nothing to recommend it.

THE YOLK CURE

Egg yolks as an addition to the diet of the underfed and badly nourished are often of the greatest service in a variety of forms of faulty nutrition. In certain instances in which there is inability to assimilate the entire egg, the yolks are of great value. A daily portion of from ten to forty yolks may be added to the customary diet. The white of the egg consists of a solution of protein shut up in the interior of many millions of cells. The protein of the white of egg is called "egg-albumin." The yolk is a storehouse of nutriment for the young chick, and consequently has a very different composition from the white.[1] It contains much less water and more solids, among the latter being a large proportion of fat. The general composition of the white and yolk is contrasted in the table on page 351, to which the reader is referred. The palmitin, stearin and olein are simply fats such as we have already encountered in butter and have the same nutritive value as these. Their presence in the form of an emulsion in the yolk makes them more easily digested, which renders the yolk particularly suited to individuals whose nutrition is below par and who do not do well on ordinary diets.

Stern(33) gives the following simple dietary for a patient whose normal weight should be 140 pounds, but who, owing to debilitation, weighs only 110 pounds:

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[1] *See* Analysis of Eggs, Volume I, Chapter XII, p. 351.

DIETARY FOR DEBILITY

	Number of yolks	Calories in the yolks	Total number of calories
Breakfast:			
250 c.c. skim milk with 4 yolks;	4	200	200
30 grams wheat toast.			75
Forenoon Lunch:			
Cup of coffee, 2 yolks.	2	100	100
Dinner:			
One plate of soup, 4 yolks;	4	200	225
beef (very lean), 150 grams;			125
30 grams wheat toast.			75
Afternoon Lunch:			
25 c.c. skim milk, 30 c.c. whiskey, 3 yolks.	3	150	370
Supper:			
Porridge of farina or rice, 100 grams; 1 yolk, skim milk;	1	50	350
apple sauce, 75 grams.			30
At Bedtime:			
Night cap (90 c.c. hot water, 10 c.c. whiskey, 1 yolk, teaspoonful granulated sugar).	1	50	110
	15	750	1660

If it should be deemed expedient to continue this dietary over any great period of time, the dishes in which the yolks of eggs are incorporated should be varied as much as possible. The great richness of yolk of egg in fat and lime salts and in organic compounds of phosphorus and iron make it peculiarly valuable as an adjunct to the dietary of infants and young children, especially those which are suffering from rickets, malnutrition, athrepsia, etc., for it is these very compounds which the child needs, especially the rickety child.

MILK CURES

Kumiss Cure.—Kumiss is an agreeable milk preparation readily digested and easily absorbed. It has been made for many hundreds of years by tribes of nomadic Tartars in eastern Europe from mare's milk. A substitute for it made from cow's milk is called "kephir," but this is not genuine kumiss. The general properties of kumiss and kephir are given in Volume I, Chapter XII. The so-called kumiss in this country is really kephir. Kumiss contains from 1 to 2 per cent of alcohol and effervesces on opening the bottle. It is more easily digested and more completely ab-

sorbed than ordinary milk and can be taken in large amounts. It is mildly diuretic and gently laxative, and like other milk cures, lessens intestinal putrefaction by virtue of the lactic acid which it contains. As a cure, on an average from two to four quarts are taken daily, but much larger quantities are taken in Russia at resorts where this method is in vogue. Ordinarily, kumiss is ordered in combination with nourishing food of a protein nature, carbohydrates, fruits and saccharine foods being specially restricted. If diarrhea becomes annoying, it is well to add lime water to the kumiss. In Russia, kumiss is largely employed in the treatment of pulmonary tuberculosis, but its principal value in this country lies in the fact that it is a valuable liquid food which many patients can take, with whom plain milk and its other modifications disagree. The peculiar qualities of kumiss render it a most useful foodstuff in the dietetic treatment of many stomach and bowel derangements. In the section dealing with milk will be found a complete description of the kephir granules and directions for making kephir. The analytical table, page 568, gives the analysis of genuine kumiss and kephir from mare's milk and the home-made product from cow's milk, as well as Egyptian youghourt and old-fashioned buttermilk. It will be observed that the total protein is slightly less in kumiss and kephir than in mare's and cow's milk respectively. In kumiss, the fat is practically the same as in mare's milk. On the other hand, the percentage of fat in kephir is naturally lower than cow's milk, owing to its partial removal before fermentation is begun.

Considering kephir in the light of what we have already learned as to the digestibility of cow's milk, we will easily perceive that the process of fermentation must render the latter much more easily digested and absorbed than it is in its natural state. The casein of cow's milk is the great obstacle to easy digestion, but in kephir it is readily attacked by the digestive juices; in fact, it is already partly digested when ready to serve. In the light of the facts before us, it is not difficult to understand why enormous quantities of kumiss and kephir can be disposed of in the process of metabolism without difficulty. We read, for instance, that the healthy dweller on the Steppes is capable of consuming from three to four gallons of kumiss on a hot summer day, while a debilitated consumptive can take with impunity the contents of ten large champagne bottles in twenty-four hours(34).

Kumiss and kephir are practically identical in composition, but in each the actual percentages depend somewhat on the duration of the fermentation process.

COMPOSITION OF SOUR MILK: PERCENTAGES[1]

Composition	Butter-milk	Kephir: Goat's Milk	Kumiss: Mare's Milk	Egyptian Youghourt: Cow's Milk	Home-made Kumiss: Cow's Milk, Sugar, and Yeast	Home-made Youghourt: Cow's Milk and Cultures of Bacilli
Water	90.93	87.33	89.19	47.44	88.00	89.00
Casein }	} 3.01	2.75	1.73	16.00	2.56 }	} 3 to 3.25
Albumin }		.46	.55 }	} 3.76	.32 }	
Peptones }		.26	.25 }		.25	.25 to .46
Fat	1.2	3.08	2.05	16.00	1.25	3.0 to 3.5
Sugar	3.3	2.56	2.25	14.00	3.67	1.25 to 2.0
Alcohol	0.0	1.75	1.50	....	1.60	.21
Lactic acid	0.3	1.25	1.15	2.25	.61	.5 to 1.0
Carbonic acid gas	...	.65	.75	....	1.50	1.0 to 1.25
Salts	0.6	.56	.26	2.80	.75	.20

[1] This table is derived from analyses by Atwater, Hammarston, Fleischmann, Hartier, Sharp, Stange, Dujardin-Beaumetz, Wanklyn, Richmond, etc.

The kumiss cure is suitable for gastric and pulmonary catarrh. Sometimes it is beneficial in anemia, malnutrition and convalescence from illness; mental hebetude and bodily languor and excitement of the sexual organs have been observed as sequels of the treatment.

Matzoon Cure.—Matzoon is a fermented milk product manufactured with the aid of a lactic acid ferment obtained from Syria. It is a sour, thick substance, more of the consistency of cream than kumiss. Unlike kumiss, it does not contain alcohol or carbonic acid gas, and is taken in smaller amounts. It is very agreeable, very readily digested and highly nutritious.

Buttermilk Cure.—This cure depends chiefly on two considerations: first, the low fat content, which makes it of great value where fat is not well borne; second, the presence of lactic acid bacilli. The lactic acid bacilli contained in buttermilk seem to possess the properties of driving out offending bacteria, especially those causing fermentative and intestinal conditions, and to reëstablish a more or less bacterial flora in the intestinal tract. Of late years whole milk which has been inoculated with lactic acid bacilli is frequently substituted for buttermilk, but it should be borne in mind that this artificial preparation should not be used in diseased conditions due to fat indigestion.

Of late years buttermilk and similar preparations have been very extensively used by the laity in the treatment of a great many different

ailments. Buttermilk as an aliment has certain uses in the dietary, and the following conditions, in which it is of practical value, are worthy of note:

(*a*) In conditions where fat is not metabolized, especially in acute or chronic fat diarrhea.

(*b*) In infants and children suffering from marasmus or general malnutrition due to fat diarrhea or indigestion.

(*c*) In chronic dyspepsia accompanied by constipation.

(*d*) In the fermentative diarrheas.

(*e*) In typhoid and other debilitating fevers where ordinary milk is not well borne.

(*f*) As an adjunct to the diet after surgical operations, especially if the patient does not bear plain milk well.

There is no beverage so wholesome as good buttermilk fresh from the churn. Its nutritive value is considerable, an ordinary glassful yielding about as much nourishment as two ounces of bread. It is chiefly worthy of notice as being an economical source of protein. In respect to this constituent, it is not one whit inferior to ordinary milk, and yet buttermilk in agricultural districts is usually fed to pigs. There can be no question that this is a deplorable waste of a very valuable food. When used in large quantities, buttermilk possesses diuretic properties which may be a slight disadvantage in health, but would rather enhance its value than otherwise in many diseased conditions. The chief point in which buttermilk differs from whole milk is its poverty in fat. In this respect it resembles skim milk. The loss of milk sugar from the formation of lactic acid is so small as to be of no significance. The ease with which buttermilk can be digested has led to its being recommended as a food for infants(35).

Sour Milk Cure.—Many changes take place in milk during the process of souring. The sugars to a large extent are replaced by lactic acid, alcohol and carbonic acid gas; the casein is partly broken down and precipitated to a very fine division and partly predigested while the fats and salts remain practically unchanged.

The analyses on page 568 give a pretty fair summary of the changes that occur during the process of souring.

When the fermentation process of kumiss and kephir is allowed to go for only twelve hours, it is slightly sour and somewhat resembles milk in taste and appearance. When fermented for twenty-four hours, some of the casein will be dissolved, and as a result, the kumiss will be thinner but sourer. If the fermentation process is allowed to continue another

ANALYSES OF CHANGES OCCURRING IN THE FERMENTATION OF MILK

	Protein, Per cent	Sugar, Per cent	Fat, Per cent	Salts, Per cent	Alcohol, Per cent	Lactic Acid, Per cent
Kumiss (1).........	2.2	1.5	2.1	0.9	1.7	0.9
Kephir (2)..........	3.1	1.6	2.0	0.8	2.1	0.8
Mare's Milk (3)....	2.6	5.5	2.5	0.5	...	...
Cow's Milk (4).....	3.3	4.8	3.6	0.7	...	...
Buttermilk (5)......	3.8	3.3	1.2	0.6	...	0.3

day, it will be still thinner and sourer, and more thoroughly charged with carbonic acid gas. The percentage of alcohol varies from 1.5 at the end of 12 hours to as much as 3.0 per cent at the end of 36 hours.

The sour milk cure is extensively used in Turkey, Servia, Bulgaria and neighboring countries. The Bacterium caucasicus, or Bulgarian bacillus, is the most active of the lactic acid ferments, and in these countries it is extensively used to sour milk for a beverage. This Bacillus bulgaricus when introduced into the intestinal tract in large numbers will check the growth of offending bacteria and greatly lessen the number of other organisms.

During recent years, a valuable method of treatment by means of soured milk and other methods of administering selected lactic germs has been brought to the notice of the profession by the distinguished French bacteriologist, Eli Metchnikoff, of the Pasteur Institute, Paris. The Metchnikoff method has of late years become a fashionable craze, and, as is usual when a new therapeutic method is introduced, exaggerated claims have been made in its favor. While our knowledge of this method of treatment is by no means complete, yet clinical experience has abundantly proven that it is a real advance in trophotherapeutics, and we will therefore give a short account of it as laid down by Metchnikoff. It is unnecessary to state here that this food exerts an influence on the normal bacterial content present in the intestinal canal.

This dependence of intestinal microbial growths on the nature of food is due to the fact that certain bacilli secrete substances which render the soil unsuitable for others, so that by selecting an organism which is innocuous to human beings, we are enabled to destroy active germs productive of injurious effects. In order to attain this, we must secure, if possible, an antiseptic mechanism which, once started, will maintain its effect, and this can only be accomplished by the services of a living organized ferment. It is well known that lactic acid is a powerful anti-putrefactive agent. When milk turns sour, that is to say, when the milk

sugar has undergone lactic fermentation with the formation of lactic acid, it can then resist putrefaction for a long time.

The knowledge of the action of lactic acid in souring milk induced Metchnikoff to employ cultures of the lactic germs in order to produce nascent lactic acid just where its action is most needed. The culture product by which these results were secured is known as "lacto-bacilline."

During the ingestion of meals, fresh microörganisms attached to uncooked food find their way into the intestinal tract, and these invaders intensify the effect of preëxisting colonies in inducing putrefaction of the intestinal contents and noxious fermentations, particularly butyric acid fermentation. The lactic acid content in sour milk can prevent butyric fermentation and putrefaction, both of which are capable of causing various disorders in the human organism, and sour milk finds its greatest efficacy in hindering decomposition changes in the alimentary canal. In endeavoring to combat intestinal putrefaction, instead of prescribing lactic acid, which is oxidized or excreted by the kidneys, it is better to introduce the fresh living lactic germs into the digestive tract, either in the form of buttermilk, lacto-bacilline powder, tablets or soured milk. The lactic germs on reaching the intestines multiply with great rapidity, and, depending upon the supply of sugar, which is necessary for their maintenance, they set free lactic acid that permeates the intestinal contents, inhibiting putrefaction and all irregular fermentation. Milk, in order to undergo thorough lactic acid fermentation, must have planted in it the organized ferments—the living microbes—cultures of the Bulgarian bacillus, which may be added in the form of lacto-bacilline powder or tablets, which is a most active producer of lactic acid, coagulating milk within a few hours and curdling it without the assistance of any other organism. When milk is treated by this method a very large proportion of the casein is rendered soluble and a still greater percentage of the phosphate of lime has its solubility similarly increased.

Lactic acid therapy is indicated in certain cases of chronic intestinal catarrh, pernicious anemia, subacute and chronic nephritis, rheumatism, gout and diabetes. This treatment is especially indicated and of great value in cases of intestinal toxemia, intestinal intoxication resulting from the abnormal putrefaction of proteins; but it is of little value in putrefactive conditions resulting from carbohydrate fermentation.

Milk Cure. — The milk cure, or an exclusive milk diet, has been recommended for various diseased conditions. It is carried out systematically at certain health resorts in different countries, more especially in Switzerland and Germany. The cure consists of the consumption of ordi-

nary milk in its pure, undiluted, uncooked condition. To obtain the best results, the milk should be fresh and warm, just as it is drawn from the cow, since in this condition it is almost entirely free from bacteria and contains the greatest proportion of enzymes, and possesses the highest bactericidal capacity. The milk cure is exceedingly ancient and is of great value in the treatment of tuberculosis, nervous disorders and many conditions of debility and malnutrition. Its peculiar value lies in that milk is easily digested, comparatively unirritating, and, when used exclusively, tends to lessen abnormal fermentation in the intestinal tract. It is the food *par excellence* for the infant, as it supplies the precise need for growth and development.

The application of the milk cure is carried out with the best results in rural districts or places where cattle are kept for the purpose. The milk should be raw or at a temperature of the atmosphere, and, whenever possible, it should be conveyed direct from the cow to the patient in the shortest possible time to avoid the loss of enzymes and anti-bodies contained in it. Even in the winter months, it should not be heated above 140° F. because lecithin, the vitamines, and other important bodies are destroyed by a temperature beyond this degree. The vitamines contained in milk are of the greatest importance. This subject has already been covered in the section dealing with milk in the chapters on Animal Foods, to which the reader is referred.[1] Too much emphasis cannot be laid on the fact that milk should be taken raw and as soon after being drawn from the cow as circumstances will permit. It should not be forgotten that the bactericidal power of milk diminishes very rapidly after it is drawn, and a few hours after milking it is practically *nil*. It is true that boiling milk destroys bacteria, and until a few years ago it was customary to recommend that all milk should be boiled for two or three minutes before being ingested. In the light of recent knowledge, it is considered that pure and wholesome milk should not be subjected to heat, for, as just pointed out, a temperature beyond 140° F. destroys lecithin and other important bodies, including the vitamines.

In order to supply the economy with sufficient protein to yield the requisite amount of energy, a considerable quantity of milk must be consumed. Good whole milk of average quality has a heat value of 325 calories per pint. If milk is taken in large quantities, digestive derangements are liable to occur from the formation of large curds in the stomach; if these pass into the small intestines they are apt to be matted and as a

[1] *See* Volume I, Chapter XII; Volume II, Chapter IX.

result offer much resistance to the digestive enzymes and may cause diarrhea, on the one hand, or constipation with dry feces on the other.

When milk is used as the only article of diet, it should be given at first in quantities not to exceed half a glass every second hour; after two or three days two-thirds of a glass may be given at a time, and later, a whole glass or eight ounces. The milk should be drunk very slowly, in fact it should be sipped; it should be taken at regular intervals during the day and two or three times at night. As many as twelve glasses, eight ounces each, should be prescribed during the twenty-four hours. Constipation is not an unfavorable indication when taking the milk cure, but means that the milk is well digested and well absorbed. It can be counteracted by mild laxatives. On the other hand, vomiting and diarrhea indicate digestive disturbances and malassimilation. At the beginning of the milk cure, patients often lose flesh, but when taking the maximum quantity, they hold their own, or may even gain in flesh. Milk is one of the most digestible foods. Three liters, equal to about five pints, should be taken daily. This amount would supply an adult with sufficient energy for the performance of light work, yielding about 2,050 calories, which is necessary for the maintenance of nitrogen equilibrium. When less than this quantity is consumed, most people show loss of nitrogen.

The milk cure is recommended by physicians for several reasons: (*a*) to maintain the nitrogen balance; (*b*) to sustain the patient's strength; (*c*) to produce gain in body weight, and (*d*) sometimes to unload the system of superfluous weight, water, purins, complex amides, extractive nitrogenous matter, etc., which are considered deleterious to health. The object of Weir Mitchell's treatment(36) of forced feeding is to cause a gain of protein for the benefit of enfeebled, nervous and muscular systems, which is supplied from a milk diet slowly increasing from two to as much as five pints of milk by the end of the eighth day. This subject has already been considered in the present chapter (page 549).

When a milk cure is prescribed, nothing but milk is allowed for the first two weeks, unless it becomes necessary to alter the flavor or modify the constituents of milk. The flavor may be varied by adding small quantities of salt, celery salt, burnt sugar or extract of malt. If there is a tendency to form large curds, this may be prevented by the addition of lime water, barley water, oatmeal water or malt extract. If there is a tendency to nausea, it may be prevented by the above modifications. If flatulence becomes annoying, it can be prevented by the addition of Vichy water, a little salt or bicarbonate of soda. A patient on a strict milk diet may complain of a thick, white-yellowish pasty coat on the tongue, and

a disagreeable mawkish taste in the mouth. As previously stated, the beginning of the milk cure is in reality a period of starvation or underfeeding, as a patient in bed at absolute rest requires 1,600 calories of energy daily, which would require the ingestion of four pints of milk. Underfeeding may cause restlessness and insomnia. Casein indigestion from excess of fat or want of freshness in the milk may lead to diarrhea. The urine is increased in quantity, while the excretion of uric acid and purin bodies is lessened; but the quantity of urea is in proportion to the digested casein, and the urine ofttimes has a greenish tinge. Indican and similar compounds disappear from the urine. As the quantity of milk consumed increases, the system becomes satisfied, insomnia complained of at the beginning is replaced by drowsiness, which is a hopeful sign when the tongue is clear and the pulse good. At the beginning of the third week, or after, the patient should be gaining in flesh, the appetite will return, and a desire for solid food will be increased. In another fortnight a little fish or fowl may be allowed in the middle of the day, and at the end of one month a gradual return to the ordinary diet is advised.

Skim Milk Cure.—The skim milk cure is employed in the dietetic treatment of valvular disease, nephritis, gout, obesity, chronic bronchitis and emphysema. It must not be overlooked that skim milk as an aliment only partially supplies the energy expended by the body, that it in reality is a system of underfeeding, and where it is the only aliment, its continued use will reduce the strength, weight and vitality of the patient. One author [1] reports 200 cases in which he employed skim milk as a diet for unloading the system generally, more especially the vascular system. When this method of treatment is instituted, it is recommended that the quantity allowed should be from one-fourth to one-half a pint of skim milk three or four times a day, sipped slowly. The milk should be fresh and obtained twice daily. Donkin is quoted as having had considerable experience in the treatment of disease by the skim milk diet and highly recommends it in diabetes, beginning with four pints daily and increasing sometimes to a maximum of twelve pints. Lenhartz has systematically employed the skim milk diet for many years past in the treatment of heart disease with failure from compensation. Under his method, the patient is placed in bed absolutely at rest for the first five days and is allowed seven ounces of milk four times a day. During the next six days he is allowed one egg, some zwieback in addition to his daily allowance of milk, and a little later some minced meat and vegetables are added, so that

[1] Carell, in 1865, quoted by Tibbles.

about the twelfth day there is a gradual return to a full mixed diet. Lenhartz claims that the failure of relief with this treatment is to be regarded as a sign of advanced degeneration of the cardiac tissue.

Whey Cure.—The whey cure has been extensively used at the various springs and baths in the mountainous districts of Germany and Switzerland, notably Ems and Reichenhall and those of the alkaline waters, which are frequently mingled with the whey and drunk either warm or cold. The treatment, like that of the dry diet previously described, is rigorous and consists in confining the patient's daily alimentation largely to the use of twenty or more ounces per diem of fresh milk whey.

The principles of this method of treatment are quite similar to those of the milk cure, but in whey the casein of the milk has been artificially removed by the precipitation of casein by rennin, as in cheese making. Whey is a thin semi-transparent liquid of a pleasing sweetish taste. According to Atwater it has the following percentage composition:

	Per cent	
Protein	1	to 1.25
(Casein, Albumin)		
Fat	0.3	to 0.5
Sugar	3.5	to 5.0
Mineral matter	0.103	
Lactic acid	0.33	
Fuel value, 145 calories per pint.		

Whey is a nutritious beverage useful in the dietetic treatment of disease, particularly as a diluent of cow's milk for feeding infants. It is easily digested, is bland and unirritating to the stomach, but it may cause flatulence and acidity in people who are subject to these troubles.

By referring to the section dealing with milk in the chapter on Animal Foods,[1] a full and explicit consideration of this subject will be found. The whey cure is advocated in some cases of chronic indigestion and abdominal plethora. It is also used in the treatment of Bright's disease and chronic catarrhal conditions of the alimentary canal. Thompson (37) recommends it particularly for chronic dyspepsia and chronic irritable cough accompanying catarrh of the respiratory mucous membranes. In abdominal plethora as much as eight to ten tumblerfuls may be added daily to a diet of fruit and vegetables. It is often combined with the grape diet, described on page 546. When taken in large amounts, whey has a tendency to produce diarrhea.

[1] *See* Volume I, Chapter XII, p. 307.

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CHAPTER XVII

PREPARATION OF SPECIAL BEVERAGES AND FOODS

WITH

Directions for Their Preparation

General Considerations; Beverages; Peptonized and Predigested Foods; Beef Teas; Meat Juices; Broths; Bouillon; Vegetable Soups; Meat Soups; Farinaceous Foods; Bread; Cereal Foods; Gruels; Eggs; Fish; Poultry; Meats; Vegetables; Purées; Fruits; Nuts; Jellies; Custards; Puddings; Ice Cream; Recipes for Diabetic Foods.

GENERAL CONSIDERATIONS

In the chapter on the Hygiene of Eating, the necessity for making foods as palatable and as attractive as possible was emphasized. The appetizing preparation of food for the sick is just as important as the careful compounding of a prescription containing medication. Convalescent patients, as well as patients ill with gastric disturbances, can easily be nauseated by the repugnant appearance of a dish, while, on the other hand, the appetite may be stimulated by food of an inviting attractive appearance. The tray on which it is served should be covered with pure white linen without a crease or wrinkle, the best that the home of the patient can afford. The silver should be spotless; the china, the daintiest, and the glassware, the clearest; all arranged neatly and conveniently. This arrangement of the tray is of the utmost importance, and the slightest departure from regularity and immaculate cleanliness should be avoided.

Foods should never be served too hot, lest the patient be tempted to partake of it in that condition in spite of the physician's or nurse's warning. On the other hand, it should not be served too cold. For this reason it is advisable to serve such dishes as are liable to cool off rapidly in ves-

sels of a double bottom, the interspace being filled with hot water. Condiments have no place in the dietary of the invalid or convalescent. Spices, however, may be used with caution, but only with permission of the physician. A tray with food should always be carried into the sick-room covered with a clean napkin or tray cover. When the dietary ordered is limited in variety, the patient is often gratified by having his food served in courses, and will eat more than if given everything at once. A patient suffering with bowel disorder should never be offered food until some time has elapsed after using the bed-pan. Needless to state, the diet of a patient should be under the supervision of the physician and his directions followed implicitly, for much unnecessary suffering and even death has followed the ingestion of forbidden food.

BEVERAGES

PLAIN BEVERAGES

Lime Water.—Place a handful of fresh unslaked lime in an earthen jar containing hot water; stir, pour off, and throw away the water as soon as it has settled. This first water contains the soluble potash salts which may be present in the lime. Add more water; allow it to settle, then decant the clear fluid and bottle it. Water may again be added to the lime, and the mixture covered and allowed to stand to be decanted as needed.

Apple Water.—

Water (boiling)	1 cupful	250 c.c.	
Apples	2 mashed baked	150 gm	144 calories

Pour the boiling water over the apples; cool, strain and sweeten. Serve with shaved ice if desired.

Tamarind Water.—

Boiling water	1 cupful	250 c.c.	
Preserved tamarinds	1 tablespoonful	20 grams	100 calories

Pour the boiling water over the preserved tamarinds; allow this to stand until cool, then strain and serve with shaved ice.

Currant Juice (Fitch).—

Currant juice	1 ounce	30 c.c	25 calories
or			
Currant jelly	1 tablespoonful	35 grams	113 "
Boiling water	1 cupful	250 c.c.	

Over the currant jelly pour the boiling water (use cold water with the juice) and sweeten to taste.

Lemonade No. 1 (Thompson).—

Lemon juice	3 tablespoonfuls	45 c.c.	
Sugar	3 "	30 grams	123 calories
Cold water	1 cupful (6 ounces)	250 c.c.	

To the juice of the lemon add the sugar and the cold water. Serve with cracked or shaved ice if desired.

Lemonade No. 2 (Pavy).—

Rind of lemon	1	3 grams.	
Boiling water	1 pint	480 c.c.	
Sugar	1 ounce	30 grams	114 calories

Pare the rind from the lemon, cut the lemon into slices, and place both in a pitcher with the sugar. Over this pour the boiling water and let it stand until cool. Strain and serve with cracked ice.

Effervescent Lemonade.—This may be made by using a carbonated water or by adding half a teaspoonful of bicarbonate of soda or potash to a glassful of either of the foregoing lemonades.

Albuminized Lemonade (Watson).—

Water	1 cupful	250 c.c.	
Lemon juice	2 teaspoonfuls	30 "	
Sugar	2 "	20 grams	82 calories
Egg	1 white	32 "	30 "

Shake all the above ingredients together. Serve at once.

Orangeade (Ruhräh).—

Rind of orange	1	3 grams.	
Boiling water	1 cupful	250 c.c.	
Juice of orange	1	45 "	60 calories
Sugar	1 tablespoonful	20 grams	82 "

Cut the rind from the orange; over this pour the boiling water, then add the juice of the orange and the sugar; cool, strain and serve with shaved ice if desired. If this is too sweet, a teaspoonful of lemon juice may be added.

Imperial Drink (Gautier).—

Cream of tartar	1 teaspoonful	4 grams.
Boiling water	1 pint	480 c.c.
Juice of lemon	½	15 "

Add the cream of tartar to the water. Into this squeeze the juice of half a lemon, or more if desired, sweeten to taste and serve cold. This drink is most useful in fevers and in nephritis.

Barley Water (Caultey)(1).—

Thin: Put a teaspoonful of prepared or pearl barley, previously washed in cold water, into a jug; pour half a pint of boiling water on it, and add a pinch of salt. Stand it by the fire for an hour, stirring occasionally, and then strain through fine muslin. Similar thin cereal decoctions may be made from rice, arrowroot or oatmeal.

Thick: Put a heaping tablespoonful of washed, prepared or pearl barley into a clean saucepan, and add a quart of water and a pinch of salt. Boil slowly until it has evaporated down to about two-thirds of a quart, and strain. It may be flavored as desired. The addition of a little lemon peel, while boiling, is best.

The composition of barley water is 0.09 per cent protein, 0.05 per cent fat, 1.6 per cent carbohydrate. It furnishes 14 calories to 100 c.c.

Toast Water (Caultey).—Pour a pint of boiling water over two or three slices of well-toasted bread. Let it stand until cool; strain.

Linseed Tea (Yeo).—

Water	1 pint	480 c.c.	
Linseed	2 tablespoonfuls	60 grams	60 calories
Juice of lemon	½	15 c.c.	
Bruised licorice root (or a piece of licorice the size of a filbert)	¼ ounce	8 grams	10 "

To the water add the linseed, the juice of the lemon, the licorice root, and rock-candy to taste. Boil for one and one-half hours and strain.

Orgeat (Pavy).—

Sweet Almonds	2 ounces	32 grams	200 calories
Almond seeds (bitter)	4	1 gram.	
Orange-flower water	a little	30 c.c.	
Milk	1 pint	480 "	350 "
Water	1 "	480 "	

Blanch the sweet almonds and bitter almond seeds. Add the orange-flower water and pound into a paste. Rub this with the milk, diluted with the water, until it forms an emulsion. Strain and sweeten with sugar. (A demulcent and nutritive drink.)

NUTRITIOUS BEVERAGES

Albumin Water (Friedenwald and Ruhräh).—

Egg	1 ounce	50 grams	80 calories
Water	6 ounces	180 c.c	
Sugar	1 teaspoonful	10 grams	41 "
Lemon juice	1 "	4 c.c	

Beat the white of the egg until very light and strain through a clean napkin. Add the water. If intended for an infant, a pinch of salt may be added. The sugar and lemon juice, or sherry wine, may be added to enhance its palatableness. This drink may also conveniently be made by placing all the ingredients in a lemonade shaker, shaking until thoroughly mixed and then straining. Serve cold.

Egg Albumin Water (Watson).—Take the white of an egg (30 calories) and to it add twice its own volume of water and strain through muslin. This gives about three ounces of a clear solution, containing as much protein as is found in the average sample of commercial beef juice. This fluid, added to home-made beef tea, makes a nutritive solution almost indistinguishable from beef juice and at a fraction of the cost.

Egg Albumin Water (Caultey).—Take the white of a fresh egg (30 calories) and cut it in numerous directions with scissors. Shake it up in a flask with a pinch of salt and six ounces of cold water. Strain through muslin.

It can be made with thin barley water, and cream or sugar added.

Egg Broth (Drexel Institute).—

Egg	1 (whole)	50 grams	80 calories
Sugar	½ teaspoonful	5 "	20 "
Salt	a pinch	1 "	
Hot milk	1 glass	250 c.c	180 "

Beat up the egg, and add to it the sugar and a pinch of salt; over this pour the milk and serve immediately. Hot water, broth, soup, or tea may be used in place of milk.

Egg Cordial.—

Egg	1 white	32 grams	30 calories
Cream	1 tablespoonful	50 "	54 "
Sugar	½ "	20 "	82 "
Brandy	1 "	16 c.c	65 "

Beat up the white of the egg until light; add the cream and beat up together; then add the sugar and the brandy.

Caudle.—

Egg	1 (whole)	50 grams	80 calories
Sherry wine	1 wineglassful	30 c.c	38 "
Sugar	1 teaspoonful	10 grams	41 "
Gruel barley	½ pint	120 c.c	130 "

Beat up the egg to a froth, add the wine, and sweeten with the sugar; if desired, flavor with lemon peel. Stir this mixture into the gruel, over this grate a little nutmeg, and serve with hot toast.

Cocoa with Milk.—

Cocoa	1 rounding teaspoonful	4 grams	50 calories
Milk-sugar	2 ounces	60 "	240 "
Milk	4 "	120 c.c	80 "
Cream	2 "	60 "	120 "

Mix the sugar and cocoa; cook in the milk until dissolved. Serve with the cream.

Cocoa.—

Cocoa	1 heaping teaspoonful	4 grams	50 calories
Milk-sugar	2 ounces	60	240 "
Water	½ cup (4 ounces)	125 c.c.	
Cream	3 ounces	90 "	180 "

Mix the cocoa and sugar, add the water, and boil for four or five minutes. Then add the cream, or use less and serve with whipped cream.

Coffee.—

Milk-sugar	2 ounces	60 grams	200 calories
Strong coffee	4-5 "	120-150 grams.	
Cream	2 "	60 c.c	120 "

Milk-sugar may be used likewise to sweeten tea, which may be served with or without cream.

Almond Milk (Wegele).—

Almonds, sweet	1 pound	453.5 grams	3,030 calories
" bitter	2 pounds	1,000 "	6,060 "
Milk	8 ounces	250 c.c.	165 "

Blanch the almonds that have been soaked in cold water for twenty-four hours. This is done by pouring boiling water over them, when, after a few minutes, they can easily be pressed out of their hulls. Grind the almonds in a mill or pound them in a mortar; mix with a half-pint of warm milk or water, and allow the mixture to stand two hours, after which strain through a cloth, pressing the juice out well Thirty grams of almonds yield 200 calories of heat; 250 grams of milk yield 170 calories.

Lemon Whey.—

Lemon juice	3 tablespoonfuls	45 c.c.	
Milk sugar	2-4 ounces	50-100 grams	200-400 calories

Kumiss No. 1 (Drexel Institute).—

Skim milk	1 quart	1,000 c.c	340 calories
Cake of yeast	1/8	3 grams.	
Sugar	2 tablespoonfuls	80 "	328 "

Heat the milk. Dissolve the yeast in a little water and mix it with the sugar and lukewarm milk. Pour the mixture into strong bottles, stopper them tightly with new corks, and tie down the corks with stout twine. Shake the bottles well and place in a refrigerator. This will allow the mixture to ferment slowly. After three days lay the bottles on their sides, turning them occasionally. Five days are required to complete the fermentation; the kumiss is then at its best.

Kumiss No. 2 (Holt).—

Fresh milk	1 quart	1,000 cc.	650 calories
Sugar	½ ounce	15 grams	62 "
Yeast cake	piece		3 "

Pour into wired bottles the fresh milk, sugar and fresh yeast cake (half an inch square), and keep at a temperature between 60° and 70° F. for one week, shaking five or six times a day; then put upon ice.

Further directions for preparing kumiss and kephir with kefilac tablets will be found in the section on Milk, in the chapter on Animal Foods (Volume I, Chapter XII, page 338). For the analytical value, *see* Volume II, Chapter XVII, pages 566-568.

Milk Mixture (A. V. Meigs).—

Cream	2 pints	1,000 c.c.	1,820 calories
Milk	1 pint	500 "	325 "
Lime Water	2 pints	1,000 "	
Sugar water	3 "	1,500 "	512 "

For the sugar water use seventeen and three-fourths drams of milk sugar to a pint of water.

Milk and Cinnamon Drink (Ringer).—

Add a small amount of cinnamon to the desired quantity of milk and boil it. Sweeten with sugar and add brandy if desired.

Albuminized Milk.—

Milk	1 cupful	250 c.c	170 calories
Lime water	1 tablespoonful	15 "	
Egg	1 white	32 grams	30 "

Shake in a covered jar or lemonade shaker the milk, lime water and white of the egg. Sweeten, flavor as desired, and serve at once.

Irish Moss and Milk.—

Irish moss	2 tablespoonfuls	28 grams.	
Milk	1 cupful	250 c.c	170 calories

Soak the Irish moss for five minutes and wash thoroughly in cold water. Add the milk and soak for half an hour; then heat slowly, stirring constantly, and boil for ten minutes, preferably in a double boiler; strain, and pour into cups to cool. This may be served while hot, and may be rendered more nutritious by the addition of the white of an egg stirred into it just before serving.

Egg and Buttermilk Mixture.—

Egg	1 white	32 grams	30 calories
Cream	2 ounces	80 "	216 "
Buttermilk	1 glass	250 c.c	78 "

Beat the egg and cream lightly. Pour into a glass and fill with fresh buttermilk. Stir well.

Milk and Other Diluents.—Milk may be diluted with advantage in many cases by adding lime water, or vichy, apollinaris, or some other sparkling table water. From one-half to one-eighth the total volume may be added.

Grape Juice (Drexel Institute) (2).—Pluck Concord grapes from the stem. Wash and heat them, stirring constantly. When the skins have been broken, pour the fruit into a jelly bag and press slightly. Measure the juice and add one-quarter the quantity of sugar. Boil the juice and sugar together and then pour into hot bottles; cork and seal with paraffin or equal parts of shoemaker's wax and resin melted together. Less sugar may be used.

Vanilla, Bitter Almond or Strawberry Junket.—

Vanilla or bitter almond extract	½ teaspoonful	2 c.c.	
or			
Pure concentrated strawberry sirup	1 tablespoonful	15 "	88 calories
Whole milk	½ pint	250 "	170 "

Add the flavoring extract to the cold milk and then prepare in the usual way. The vanilla or bitter almond extract or the strawberry sirup should be allowed to a half-pint of milk.

Milk Lemonade (Ruhräh).—

Sugar	2 ounces	56 grams	224 calories
Boiled milk	5 "	150 c.c	115 "
Lemon	½ "	65 grams	20 "
or			
White Wine	2 "	120 c.c	83 "
Boiling water	5 "	150 "	
Rind of lemon	½ "	5 grams.	

Pour the boiling water over the peel and the sugar; allow it to cool, add the milk, and then the lemon juice or wine. Strain after ten minutes.

Milk Porridge (Drexel Institute).—

Flour	1 tablespoonful	50 grams	85 calories
Cold milk	¼ cupful	63 c.c	45 "
Hot milk	¼ "	63 "	45 "
Salt	¼ teaspoonful	1 gram.	

Mix the flour with the cold milk and stir into the hot milk; if desired add two raisins cut into quarters. Cook over boiling water for one hour, and add the salt just before serving.

Plain Egg Flip (Watson).—

Milk	1 teacup	250 c.c	150 calories
Sugar	1 teaspoonful	10 grams	41 "
Egg	1 white	32 "	30 "

Boil the milk or make it thoroughly hot; beat up the white of egg to a stiff froth. Pour the boiling milk over the white of egg, stirring all the time. Add sugar to taste, and serve.

BEVERAGES WITH EGG AND ALCOHOL

Rich Egg Flip (Watson).—

Egg	1 white	32 grams	30 calories.
Cream	1 tablespoonful	20 "	54 "
Brandy	1 "	15 c.c	58 "
Sugar to taste	1 teaspoonful	10 grams	41 "

Beat up the white of egg stiffly; add to it the brandy and cream, with a little sugar if wished. Mix very thoroughly and serve.

Egg-nog (Fitch).—

Egg	1 (freshly laid)	50 grams	80 calories
Powdered sugar	1 tablespoonful	40 "	160 "
French brandy	1 ounce	30 c.c	105 "
Santa Cruz rum	2 drams	75 "	25 "
Fresh milk	1 glassful	250 "	170 "
Cream	1 wineglassful (2 ounces)	64 "	225 "

Break the egg, separating the white from the yolk, and beat the yolk slowly, adding the sugar until it is thoroughly dissolved; then add the brandy, at first drop by drop, vigorously beating the mixture all the time until one-half is added, then increase the flow until all the brandy is added. Now add the milk, pouring very slowly, beating the mixture all the while. Continue beating while the rum is being slowly added. An

assistant should have the white of egg beaten to a froth, which is now dropped on top of the mixture. Add a small pinch of grated nutmeg, dusting over the frothy whites, and set mixture on ice for an hour, when it will be ready to serve.

Cold Egg-nog (Watson).—

Egg	1 whole	50 grams	80 calories
Sugar	2 teaspoonfuls	20 "	80 "
Milk	1 glassful	250 c.c	170 "
Brandy or good whiskey	1 tablespoonful	15 "	55 "

Beat up the egg, add the sugar and milk and then the brandy or whiskey; mix thoroughly.

Hot Egg-nog.—

Egg	1 yolk	18 grams	68 calories
Sugar	2 teaspoonfuls	20 "	180 "
Hot milk	1 glassful	250 c.c.	170 "
Brandy or old whiskey	1 tablespoonful	15 "	55 "

Beat the egg, add the sugar and milk, and then the brandy or whiskey; mix thoroughly.

Brandy-and-Egg Mixture (Stokes).—

Eggs	2 yolks	36 grams	138 calories
White sugar	¼ ounce	20 "	80 "
Cinnamon water	4 ounces	120 c.c.	
Brandy	4 "	120 "	468 "

Rub the yolks of the eggs with the white sugar, add the cinnamon water and then the brandy. Dose: One or two teaspoonfuls every two hours, according to age.

Brandy-and-Egg Mixture for Infants (Louis Starr).—

Egg	1 yolk	18 grams	68 calories
Brandy	½ ounce	15 c.c	60 "
Cinnamon water	1 teaspoonful	4 "	
White sugar	1 coffeespoonful	20 "	80 "

Beat all these ingredients up well.

Egg-nog (Ruhräh).—

Egg	1 large	60 grams	80 calories
Sugar	1 tablespoonful	30 "	120 "
Whiskey	2 tablespoonfuls	30 c.c	90 "
Cream	7 "	140 grams	210 "

Add the sugar to the yolk of egg and beat until very light. Whip the white of the egg and then the cream until very stiff. Add the whiskey

to the yolk of egg and sugar. Mix well. Add one-half the cream to this, then one-half the beaten white of egg, then the remaining cream, and finally the remaining white of egg. Mix lightly. This recipe makes a glass and a half.

Egg-nog (Bartholow) (3).—Scald some new milk by putting it, contained in a jug, into a saucepan of boiling water; it must not be allowed to boil. Beat an egg with a fork in a tumbler with some sugar; add a dessertspoonful of brandy, and fill the tumbler with the scalded milk when cold. This egg-nog will furnish about 300 calories.

Beef-tea Egg-nog (Davis).—

"Soluble Beef"	⅛ teaspoonful	0.5 grams	20 calories
Hot water	½ cupful	125 c.c.	
Brandy	1 tablespoonful	15 "	60 "
Egg	1 (whole)	50 grams	80 "
Sugar	2 teaspoonfuls	20 "	85 "
Salt	a pinch	1 "	

Beat the egg slightly, and add the salt and sugar. Dissolve the "Soluble Beef" in the hot water, add to the egg, and strain. Mix thoroughly, adding wine, and serve.

Grape Juice and Egg.—

Egg	1 white	32 grams	30 calories
Grape juice	2 tablespoonfuls	30 c.c	20 "

Beat the egg lightly, strain through a napkin, and add to it the grape juice. Fill a large wineglass half full of cracked ice. Pour the egg and grape juice over this, sprinkle sugar over it, and serve.

Milk Punch.—

Milk	1 glass	250 c.c	170 calories
Rum	1 tablespoonful	15 "	45 "
Sugar	2 teaspoonfuls	20 grams	81 "

Shake together in a lemonade-shaker the milk, rum, brandy or good old whiskey, and the sugar. After it has been poured into a glass, a little nutmeg may be grated over the top.

Egg Flip.—Boil or heat thoroughly a teacupful of milk, beat the white of one egg to a froth. Pour the milk over the egg, stirring constantly. Add sugar to taste. This will furnish 230 calories.

Caudle (Yeo).—Beat an egg to a froth; add a glass of sherry and half a pint of gruel. Flavor with a lemon peel, nutmeg and sugar. This will furnish 120 to 150 calories, according to the consistency of the gruel. If milk is used to make the gruel it will have a higher value,

Wine Whey.—

Milk	1 cupful	250 c.c	170 calories
Sherry wine	½ "	60 "	76 "

Cook the milk and sherry wine together. As soon as the curd separates, strain and sweeten. This may be eaten hot or cold.

Mulled Wine (Drexel Institute).—

Hot water	¼ cupful	30 c.c.	
Stick cinnamon	½ inch	2 grams.	
Cloves	2 whole	0.5 "	
Nutmeg	tiny bit	.05 "	
Port (heated)	½ cupful	60 c.c	106 calories
Sugar	2 tablespoonfuls	28 grams	112 "

Boil all the ingredients except the wine and sugar for ten minutes; then add the wine and sugar, strain, and serve very hot.

PEPTONIZED AND PREDIGESTED FOODS

Predigested protein, in the form of peptone and albumose, is of value principally in increasing the nutritive properties of liquid foods. Its principal value as an aliment is in its nutritive property in long-continued wasting diseases. It also has some value as an appetizer when there is diminished secretion of the gastric juice, and is of use where gastric motility and secretion are low, on account of its being a concentrated food. It is useful in artificial feeding by the stomach tube or for rectal alimentations.

Peptonized Beef (Fairchild).—

Finely minced lean beef	¼ pound	100 grams	255 calories
Cold water	½ pint	250 c.c.	
Extract of pancreas	20 grains	1.25 grams	2 "
Bicarbonate of soda	15 "	1 "	
Egg	1 white	30 "	30 "
Salt and pepper	1 saltspoon	1 "	

Cover the lean beef (or beef and chicken mixed) with the cold water. Cook over a slow fire until it has boiled for a few minutes, stirring constantly. Pour off the broth and rub or pound the meat to a paste. Put meat and broth and half a pint of cold water in a glass jar, and add the extract of pancreas and bicarbonate of soda. Mix well and keep in a warm place—at about 110°–115° F.—or place it in warm water and allow it to stand three hours, stirring or shaking occasionally. Boil quickly; strain or clarify with the egg, and season with salt and pepper.

If desired, it need not be strained, as the small particles of meat are usually easily digested. Cereals may be added, boiling with half the amount of water previously directed, and mixing all together before peptonizing. At the end of three hours the mixture must be boiled or it will spoil.

Peptonized Oysters (Fairchild).—

Oysters	½ dozen	85 grams	44 calories	
Water	½ pint	250 c.c.		
Extract of pancreas	15 grains	1.4 grams	2 "	
Bicarbonate of soda	15 "	1 "		
Milk	½ pint	250 c.c	170 "	
Salt	1 saltspoon	1 gram.		
Pepper	1 "	1 "		

To the oysters with their juice add the water, and boil for a few minutes. Pour off the broth and set it aside. Mince the oysters, and with the aid of a potato-masher reduce to the consistence of a paste. Place this with the broth in a glass jar and add the extract of pancreas and the bicarbonate of soda and mix. Allow this to stand in hot water (115° F.) for one and one-half hours. Pour into a saucepan and add the milk; heat over a slow fire to boiling point. Flavor with salt and pepper and serve hot. Let the heating be done gradually, and be careful to bring the mixture to a boil before taking it from the fire.

Partially Digested Cereals Prepared at the Table.—To a saucer of well-cooked oatmeal, wheaten grits or rice, at the customary temperature, add one or two teaspoonfuls of Fairchild's Diastasic Essence of Pancreas, or fifteen grains of Fairchild's Dry Extract of Pancreas. Stir for a few minutes before eating. When the ferments are added to the very hot foods their power becomes impaired. About 100 grams, energy value. about 200 calories.

Partially Peptonized Milk (Ruhräh).—

Milk	1 pint	500 c.c.	325 calories
Water	4 ounces	120 "	
Fairchild's peptonizing tube	1	1 gram	2 "
or			
Pancreas extract	5 grains	0.33 "	
Bicarbonate of soda	15 "	1 "	

Into a clean granite-ware or porcelain-lined saucepan place the milk, water and the contents of the tube, or the pancreas extract, and bicarbonate of soda. Heat gradually until it boils, stirring constantly. Boil gently for ten minutes, strain into a clean bottle, cork and keep in a cool

place. Before using, shake the bottle well; serve hot or cold. Prepared in this way it will not become bitter.

Peptonized Milk.—

Cold Process.—Mix milk, water and peptonizing agents as directed in the preceding recipe, and immediately place the bottle on ice. Use when ordinary milk is required. This is particularly suited for dyspeptics and individuals with whom milk does not, as a rule, agree. The flavor of the milk remains unchanged.

Warm Process.—

Milk	1 pint	500 c.c	325 calories
Cold water	4 ounces	120 "	
Extract of pancreas	5 grains	0.33 gm	2 "
Bicarbonate of soda	15 "	1 "	

Put the milk and cold water in a glass jar, add the extract of pancreas and the bicarbonate of soda. After mixing thoroughly, place the jar in water as hot as can be borne by the hand (about 115° F.). This should be heated for from six to twenty minutes. At the end of this time it may be placed upon ice until required. The contents of one of Fairchild's peptonizing tubes may be used in place of the pancreas extract. If the milk is to be kept for any length of time, it should be brought to a boil, to prevent the formation of too much peptone, which renders the milk bitter.

Hot Peptonized Milk.—Mix together the usual peptonizing ingredients and add a pint of fresh cold milk. After thoroughly shaking the bottle place it on ice. When needed, pour out the required amount, heat it, and drink it as hot as it can agreeably be taken. If required for immediate use, the ingredients may be mixed together in a saucepan and slowly heated to the proper temperature.

Effervescent Peptonized Milk.—Put some finely cracked ice in a glass, fill it half full of Apollinaris, vichy or siphon water, and immediately add the peptonized milk. Drink while effervescing. Brandy may be added if desired.

Specially Peptonized Milk.—This is to be used in the preparation of jellies, punches and all recipes where the milk is to be mixed with fruit juices or acids. Prepare according to the hot process; keep the milk at a temperature of 115° F. for one hour; pour into a saucepan and bring to a boil. If required hot, this may be used immediately, or it may be set aside on ice, to be used later. If not heated for an hour, the milk will curdle on being mixed with an acid. If not boiled, the peptonizing ferment will digest gelatin and prevent the formation of jelly.

Peptonized Milk Jelly (Friedenwald and Ruhräh).—

Cox's gelatin	½ box		
Water	4 ounces	120 c.c.	
Hot specially peptonized milk	1 pint	500 "	325 calories
Sugar	4 ounces	112 gm	410 "
Fresh lemon	1 whole	130 "	41 "
Orange	1 "	250 "	96 "
St. Croix rum or brandy	3 tablespoonfuls	50 c.c	245 "

Soak the gelatin well in the water. Take the peptonized milk and add the sugar. Put in the gelatin and stir until it is dissolved. Pare the lemon and orange, and add the rinds to the mixture. Squeeze the lemon and the orange juice into a glass, strain and mix with the rum or brandy if preferred. Add the juices to the milk, stirring constantly. Strain, and allow it to cool to the consistence of sirup. When almost ready to set, pour into cups and set in a cold place. Do not pour the milk into moulds until the mixture is nearly ready to set, otherwise it will separate in setting.

Peptonized Milk Lemonade.—

Cracked ice	⅛ glass	80 c.c.	
Juice of	1 lemon	20 "	
Sugar	3 teaspoonfuls	30 gm	100 calories

Squeeze into the cracked ice the lemon juice, and add the sugar dissolved in water. Fill the glass with fresh specially peptonized milk and stir well. If preferred, equal parts of milk and of an effervescent mineral water may be used. Pour the water on the lemon juice and ice, and immediately fill the glass with milk.

Peptonized Milk Punch.—

Finely crushed ice	⅛ goblet	80 c.c.	
Rum	1 tablespoonful	15 "	50 calories
Curacao	a dash	5 "	15 "
Nutmeg	a pinch		

In the usual milk punch recipes the specially peptonized milk may be used in place of ordinary milk. Take the ice, pour on it the rum and Curacao, or any other liquor agreeable to the taste. Fill the glass with peptonized milk; stir well, sweeten to taste, and grate a little nutmeg on top.

Peptonized Milk Gruel.—

Wheat flour	1 teaspoonful		
Cold water	½ pint	250 c.c.	
Cold milk	1 pint	500 "	340 calories

Mix the wheat flour, arrowroot flour or Robinson's barley flour with the cold water. Boil for five minutes, stirring constantly. Add the cold milk and strain into a jar; add the usual peptonizing ingredients; place in warm water (115° F.) for twenty minutes and then upon ice.

Junket, or Curds and Whey.—

Fresh milk	½ pint	250 c.c	180 calories
Fairchild's essence of pepsin	1 teaspoonful		

To the milk add the essence of pepsin and stir just sufficiently to mix. Pour into custard cups, and let it stand until firmly curdled. It may be served plain or with sugar and grated nutmeg. It may be flavored with wine, which should be added before curdling takes place.

Junket with Egg.—

Egg	1 whole	50 gm	80 calories
White sugar	2 teaspoonfuls	20 "	42 "
Warm milk	½ pint	250 c.c	180 "
Essence of pepsin	1 teaspoonful	4 "	

Beat the egg to a froth, and sweeten with the sugar; add this to the warm milk, and then add the essence of pepsin and let it stand until curdled.

Cocoa Junket (Fairchild).—

Cocoa	1 even tablespoonful	16 gm	100 calories
Sugar	2 teaspoonfuls	20 "	82 "
Boiling water	2 tablespoonfuls	30 c.c.	
Fresh, cool milk	½ pint	250 "	180 "
Fairchild's essence of pepsin	1 teaspoonful	4 "	

Put the cocoa and sugar into a saucepan; scald with the boiling water and rub into a smooth paste; then stir in thoroughly the milk; heat this mixture until it is lukewarm—not over 100° F.; add the essence of pepsin, and stir just enough to mix; pour quickly into small cups or glasses, and let it stand until firmly curdled, when the junket is ready for use. It may be placed on ice and eaten cold; as a dessert it may be served with whipped cream.

Coffee Junket.—

Sugar	2 teaspoonfuls	20 gm	82 calories
Clear, strong coffee	2 tablespoonfuls	30 c.c.	
Fresh, cool milk	½ pint	250 "	180 "
Fairchild's essence of pepsin	1 teaspoonful	4 "	

Dissolve the sugar in the coffee; mix this thoroughly with the milk; add the essence of pepsin as directed above, and serve in the same way.

Iodized Junket.—

Milk	½ teacupful	120 c.c	85 calories
Pepsin	2 or 3 teaspoonfuls		

Prescribe a saturated solution of potassium iodid and also a bottle of essence of pepsin. Take the milk and add the required number of drops of the iodid solution. Heat the milk lukewarm and add the two teaspoonfuls of pepsin and let it stand until curdled. This will be found useful where it is difficult to administer the iodid by ordinary methods.

Whey.—

Fresh milk	½ pint	250 c.c	180 calories
Essence of pepsin	1 tablespoonful		

Heat the milk lukewarm (115° F.), add the essence of pepsin, and stir just enough to mix. When this is firmly coagulated, beat up with a fork until the curd is finely divided and then strain. For flavoring purposes lemon juice or sherry wine may be added.

Grape Juice Whey.—

Orange	1, juice of	60 c.c	45 calories
Grape juice	¼ pint	120 "	180 "

Make whey as in the above recipe. To this add the juice of the orange and the grape juice. Strain again if necessary. This may be served hot or on cracked ice. It may be sweetened if desired. Energy about 225 calories.

Cream-of-Tartar Whey (Pavy).—

Cream of tartar	1 heaping teaspoonful		
Boiling water	1 pint		
Milk	1 cup	250 c.c	180 calories

Add the cream of tartar to the boiling water. Strain, sweeten to taste, and serve cold. Energy about 180 calories.

BEEF TEAS

Beef Tea (Pavy).—

Finely minced beef	1 pound	454 gm.	1,000 calories
Cold water	1 pint	500 c.c.	
Salt	½ teaspoonful	2 gm.	

Put the beef with the cold water into a suitable vessel. Let it stand for an hour, stirring occasionally. Put the vessel containing the beef into

a saucepan of water, place it over the fire, and allow the water to heat gently for an hour (or the vessel containing the beef tea may be put into an ordinary oven for an hour). Pass the beef tea through a strainer. A fine sediment appears in the fluid, and this should be drunk with the liquid. Flavor with salt. At no time should the beef extract be exposed to a temperature of more than 170° F.

Beef Tea (Bartholow).—

Beef	1 pound	454 gm.	1,000 calories
Cold water	1 pint	500 c.c.	

Chop the beef fine, free from fat, tendons, etc., and soak with the cold water for two hours. Let it simmer on the stove for three hours at a temperature never above 160° F. Replace the water lost by evaporation by adding cold water, so that a pint of beef tea shall represent a pound of beef. Strain and carefully express all fluid from the beef.

Beef Tea with Oatmeal (Yeo).—

Groats	1 tablespoonful	30 gm.	104 calories
Cold water	2 tablespoonfuls	30 c.c.	
Boiling beef tea	1 pint	500 "	150 "

Mix thoroughly the groats and cold water; add to this the boiling beef tea. Boil for ten minutes, stirring constantly. Strain through a coarse sieve.

Beef Tea (Caultey).—1. Mince one pound of lean beef, and add to it one pint of cold water and ten drops of dilute hydrochloric acid. Let it stand for two or three hours, with occasional stirring, and then simmer for ten to twenty minutes. Do not let it boil. Skim well. Energy value 25 calories to 100 c.c.

2. Mince one pound of lean beef as fine as possible, and pound it in a mortar with a small teaspoonful of salt. Add the meat and its juice to one pint of water at 170° F. in an earthen vessel, and stand it for an hour by the fire, stirring at times. Then strain it through muslin, taking care to squeeze all the juice out of the meat. It furnishes 25 calories to 100 c.c.

The composition of beef tea, Nos. 1 and 2, is 92.9 per cent water, 4.4 per cent protein, 0.4 per cent fat, 1.1 per cent carbohydrate.

Beef Tea, Flavored (Yeo).—Beef tea may be flavored agreeably by boiling in it a pinch of mixed herbs, a bay-leaf or a bit of onion, carrot, turnip or celery and a few peppercorns. The roots should either be chopped small or be scraped to a pulp before being added to the broth.

Thick Beef Tea, No. 1 (Watson).—

Beef tea (made)	½ pint	250 c.c	75 calories
Egg	1 yolk	18 gm	68 "
Tapioca grout	1 teaspoonful	5 "	15 "

Warm the beef tea and sprinkle in the tapioca, stirring all the time. Let it simmer slowly by the side of the fire until the tapioca turns quite clear. This will probably take about fifteen minutes. Beat up the yolk of an egg in a cup, pour the beef tea gradually over it, stirring all the time. It is now ready for serving.

Beef Tea, No. 2 (Watson).—

Beef tea (made)	½ pint	250 c.c	75 calories
Arrowroot	1 teaspoonful	5 gm	15 "
Cold water	1 "	4 c.c.	

Mix the arrowroot and the water in a small basin until quite smooth. Then add it to beef tea that is being warmed in a pan; stir well for a few minutes to prevent it from becoming lumpy. Then simmer slowly for fifteen minutes.

MEAT JUICES

This variety of food differs greatly in nutritive value from the beef teas and essences previously mentioned. The meat juice is extracted without any heat and under strong pressure, and thus a large portion of the albumin is present.

Home-made meat juice is cheaper than the proprietary preparations, and is more valuable on account of its freshness, and the absence of preservatives. It contains a relatively small quantity of extractives, and can be given in considerable amounts without causing diarrhea or thirst. The great drawback to the home-made product is its red color, which is decidedly objectionable. This can be partially overcome by serving in a red glass or a cup.

Home-made Meat Juice (Watson).—

Rump steak (best)	¼ pound	115 gm	330 calories
Cold water	1 gill	125 c.c.	

Pinch of salt or sugar to taste.

Wipe and shred the meat very finely, pound it well, and rub it through a fine wire sieve. Place in a basin with water and salt, and let stand, stirring occasionally, for a couple of hours. The liquid will then be a bright red color. Strain through a fine strainer, pressing the meat with

the back of a spoon. The fluid obtained will contain 4 to 5 per cent of protein.

Meat juice should be made in very small quantities, as it very soon becomes rancid. Another method, such as squeezing the meat in a lemon squeezer, may be tried, but this is wasteful, as the pressure is not sufficiently powerful to extract all the juice.

Meat-Juice Mince (Watson).—

Rump steak (best)	½ pound	230 gm	660 calories
Butter	1 small piece	15 "	120 "
Pepper and salt	½ teaspoonful each	2 "	

Rub the meat through a hair sieve until all the red juicy part has gone through; scrape the bottom of the sieve. Melt a very little piece of the butter in a small frying-pan; toss the meat juice in it for three or four minutes, until it loses its red color. Flavor and serve with toast. This looks just like mince, but as none of the fiber is present, it is very digestible. This meat-juice mince can be made more easily digestible by omitting the butter, and adopting the following method: Add to the scraped meat a teaspoonful of beef tea or simple stock, and stir in an iron pan for three or four minutes, when the juice granulates and becomes brown in color. If an enamel pan is used, the meat has a very unappetizing appearance.

Beef Juice (Bartholow).—Broil quickly some pieces of round or sirloin steak, of a size to fit in the cavity of a lemon squeezer previously heated by dipping in hot water. The juice should be received into a hot, colored (preferably red) wine glass, seasoned to taste with salt and cayenne pepper, and taken hot.

Beef Juice (Caultey).—Chop lean beef fine, or scrape with a fork or meat scraper to separate the connective tissue, and put it in a jar or cup with a pinch of salt and enough cold water to cover it. Allow it to stand from one to six hours, and then squeeze well through coarse muslin. It may be given alone or mixed with other foods, warm or cold, but not hot. It should be warmed by heating the vessel in hot water.

Beef Juice (Ringer).—Take one ounce of fresh beef, free from fat, chop fine and pour over it eight ounces of cold water; add five or six drops of dilute hydrochloric acid and fifty to sixty grains of common salt, stir it well, and leave for three or four hours in a cool place. Then pass the liquid through a hair sieve, pressing the meat slightly, and adding gradually toward the end of the straining about two more ounces of water. The liquid thus obtained is of a red color, possessing the taste of soup,

It should be taken cold, a teaspoonful at a time. If preferred warm, it must not be put on the fire, but heated in a covered vessel placed in hot water. It furnishes 25 calories to 100 c.c.

The composition of beef juice is 90.6 per cent water, 5 per cent protein, 0.6 per cent fat.

Beef Essence (Yeo).—

Lean beef	1 pound	460 gm	1,320 calories
Salt	a little		

Chop the lean beef very fine, free from fat and skin; add the salt and put into an earthen jar with a lid; fasten up the edges with a thick paste, such as is used for roasting venison in, and place the jar in the oven for three or four hours. Strain through a coarse sieve, and give the patient two or three tablespoonfuls at a time. Energy value 25 calories to 100 c.c.

Cold Beef Juice.—

Finely chopped lean beef	1 pound	452 gm	1,000 calories
Cold water	8 ounces	250 c.c.	

Cover the beef with the cold water and allow it to stand for eight or ten hours. Squeeze out the juice by means of a muslin bag; season with salt or sherry wine, and drink cold or slightly warmed. It may be added to milk, care being taken that the milk is not too hot before the juice is added.

Iced Meat Extract (v. Ziemssen).—

Fresh beef	2 pounds	1 kilo	2,000 calories
Sugar	½ pound	250 gm	1,000 "
Freshly expressed lemon juice	7 ounces	200 "	50 "
Cognac containing vanilla extract	⅔ ounce	20 "	5 "
Eggs	3 yolks	54 "	204 "

Cut the fresh beef into pieces the size of a hand; wrap in a coarse, lattice-like linen bag, put under a lever press, and press slowly. The juice should be caught in a porcelain dish. This is best done by a druggist. By this method about 500 grams of juice are obtained. Mix the juice with the sugar and lemon juice (this last is best omitted in the case of dyspeptics) and the cognac; stir in well the yolks of the eggs, and place the entire mixture in a freezer. Energy value 25 calories to 100 c.c.

BROTHS

Broths, beef teas, etc., are home-made infusions of beef, mutton, veal or chicken, and are always in demand for the sick-room. They are to be

regarded, however, more in the nature of pleasant, palatable and stimulating beverages than as foods. Their nutritive value depends entirely on the method of preparation. If the process of cooking is carried to the point that the infusion contains a portion of the protein of the meat, then there is some nutritive value; but, on the other hand, if prepared after the ordinary routine, only the extractives and salts of the meat are dissolved out and, from the point of view of nutrition, the value is practically negative.

Meat Broth (Beef, Veal, Mutton or Chicken) (Sutherland).—

Chopped lean meat	1 pound	450 gm.	1,000 calories
Water	1 pint	500 c.c.	

Cover the meat with the water and allow it to stand for from four to six hours. Then cook over a slow fire for an hour until reduced to half the quantity. Cool, skim, pour into jar and strain.

Chicken Broth (Bartholow).—Skin and chop fine a small chicken or half a large fowl, and boil it, bones and all, with a blade of mace, a sprig of parsley and a crust of bread, in a quart of water for an hour, skimming it from time to time. Strain through a coarse colander. It furnishes 56 calories to 100 c.c.

The composition of chicken broth is 84 per cent water, 10.5 per cent protein, 0.8 per cent fat, 2.4 per cent carbohydrate.

Veal Broth.—

Water	1 pint	500 c.c.	
Lean veal	½ pound	225 gm.	500 calories

Pour the water on the finely chopped lean veal and allow it to stand for three hours. Boil for a few minutes, strain and season with salt.

Clam or Oyster Juice (Drexel Institute).—Cut the clams or oysters into pieces and heat for a few minutes in their juice. Strain through muslin and serve while hot. In straining great care must be taken that sand does not pass through the muslin. The juice should be diluted and may be frozen.

Clam Broth (Drexel Institute).—

Clams	3 large	75 gm.	40 calories
Cold water	½ cupful	125 c.c.	

Wash the clams very thoroughly, using a brush for the purpose. Place in a kettle with the cold water. Heat over the fire. As soon as the shells open, the broth is done. Strain through muslin, season and serve.

Mutton Broth with Vegetables.—

Neck mutton	1 pound	450 gm	1,375 calories
Water	1 pint	500 c.c.	
Carrots	2 whole	200 gm	36 "
Turnips	1 "	200 "	54 "
Onions	3 "	200 "	18 "
Barley	4 tablespoonfuls	75 "	40 "

Allow one pound of neck mutton to each pint of water; add the above ingredients. Let all simmer together for three hours.

Mutton Broth without Meat.—

"Shankends"	2 bones	1,000 gm	200 calories
Cold water	1 pint	500 c.c.	

Cook the "shankends" in the cold water, add vegetables as directed in the foregoing recipe; simmer for three hours and strain.

Invalid Broths (Thompson)(4).—To one pound of chopped lean meat—chicken, mutton or beef—add one pint of cold water; let stand in a covered glass fruit jar from four to six hours; cook for three hours in a closed jar over a slow fire, strain, cool, skim off the fat, clear with egg, season, and use warm or cold.

These broths, except the chicken broth, possess essentially the same fuel value as beef tea.

Beef Broth with Poached Eggs.—Prepare the broth in the proportion of half a teaspoonful of "Soluble Beef" to one cupful of hot water and add a poached egg.

A Nutritive Drink for Delicate Women and Children.—

"Soluble Beef"	½ teaspoonful	2 gm	30 calories
Boiling water	5 ounces	150 c.c.	
Cream	½ ounce	20 gm	72 "

Mix the "Soluble Beef," water and cream, season with salt and pepper to suit the taste.

Beef Broth and Grain.—

"Soluble Beef"	1 teaspoonful	,2 gm	30 calories
Water	1 quart	1,000 c.c.	
Rice	1 tablespoonful	15 gm	20 "

Take the above ingredients and add salt to taste. Dissolve the "Soluble Beef" in the hot water, and add the well-washed rice. Simmer slowly until dissolved and absorbed by the rice, adding more beef broth if too much boils away. If not entirely dissolved, the broth should be strained before using.

BOUILLON

Plain Bouillon (Wegele).—

Lean beef	½ kg. (1 lb.)	453 gm.	1,086 calories

Cut the beef into small pieces and put same in a vessel holding about 3 pounds (6 pints) and having a well-fitting cover (or use a double boiler). Fill vessel with cold water and allow it to cook for 3 to 4 hours. According to the strength required, it is better to add boiling water afterward, making the bouillon stronger or weaker, as desired. This makes about 2 pounds (4 pints) of bouillon—meat not to be used again. To obtain a better taste and color, one can brown the meat in a hot dry pan before putting the meat into the 6 pints of water.

Clam Bouillon (Pattee).—

Cold water	¾ cupful	187 c.c.	
Clam broth	½ "	125 "	42 calories
Scalding milk	¼ "	30 "	45 "
Butter	1 tablespoonful	15 gm.	120 "
Salt, pepper	each ½ teaspoon	4 "	
Celery sauce	1 tablespoonful	15 "	48 "
Whipped cream	1 "	30 "	81 "

Blend the water and clam broth, heat to the boiling point, then add the scalding milk, the butter and stir well; season with salt, pepper and celery sauce to taste. A small quantity of cracker crumbs may be added to thicken it. Serve in heated bouillon cups and garnish with the whipped cream.

Clam Bouillon Bisque (Pattee).—

Butter	½ tablespoonful	8 gm.	60 calories
Chopped onion	1 "	5 "	15 "
Chopped carrot	½ "	80 "	38 "
Clam broth	1 cupful	250 c.c.	84 "
Flour	½ tablespoonful	20 gm.	15 "
Boiling water	1 cupful	250 c.c.	
Egg	1 yolk	18 gm.	68 "
Cream	¼ cup	40 "	120 "

Melt the butter, add the finely chopped onion and carrot; cover and cook until the onion and carrot are tender, stirring occasionally. Add the flour, blending well; then pour on gradually the boiling water and the clam broth. Cook five minutes, strain and return to saucepan. Mix the yolk of egg with the cream, and add it slowly to the bisque. Pour into heated bouillon cups and serve with small oyster crackers.

American Bouillon, American Broth (Yeo).—Place in a tin vessel that can be scaled hermetically alternate layers of finely minced meat and vegetables. Seal it, and keep it heated in a water bath (*bain marie*) for six or seven hours, and then express the broth.

Bottle Bouillon (Uffelmann).—Cut beef, free from fat, into squares. Place these in a stoppered bottle, put the bottle in a basin of warm water, heat slowly, and boil for twenty minutes. There will be about an ounce of yellowish or brownish fluid for each three-quarters of a pound of meat used. The flavor is that of concentrated bouillon.

VEGETABLE SOUPS

Soups without Meat (Drexel Institute).—These soups are thickened by using butter and flour. This prevents a separation of the thicker and thinner parts of the soup. The butter should be heated until it bubbles, the flour and seasoning added, and enough of the hot liquid to make a smooth sauce thin enough to pour easily. This should be poured into the rest of the hot liquid and cooked in a double boiler until the soup is of the proper consistence. In soups made of dried peas and beans, soda is used to soften the casein. It is also used in tomatoes to neutralize the acid. These soups must be served in hot dishes as soon as ready. Crisp crackers, croutons, or soup sticks may be served with them.

Crisp Crackers.—Split and butter thick crackers and brown in a hot oven.

Cream-of-Tomato Soup.—

Tomatoes	1 can	450 gm.	105 calories
Soda	¼ teaspoonful	1 "	
Butter	⅛ pound	183 "	1,000 "
Flour	⅛ "	183 "	500 "
Salt	3¼ teaspoonfuls	12 "	
White pepper	½ teaspoonful	2 "	
Milk	1 quart	1,000 c.c.	720 "

Stew the tomatoes slowly one-half to one hour, strain and add soda while hot; make a white sauce and add the tomato juice. Serve immediately.

Vegetable Soup.—

Spinach	1 handful	200 gm.	16 calories
Beet	1 large	200 "	29 "
Carrots	2 small	200 "	18 "

Chop the vegetables fine and add to one quart of water. Boil two

hours, add water to make quantity up to one quart and strain. Add salt if desired. This contains a large amount of inorganic salts.

Cream-of-Celery Soup (Ruhräh).—

Celery	1½ cupfuls	250 gm.	45 calories
Water	1 pint	500 c.c.	
Milk	1 cupful	250 "	170 "
Cream	1 "	250 "	440 "
Butter	2 tablespoonfuls	30 gm.	240 "
Flour	½ cupful	140 "	400 "
Salt	½ teaspoonful	2 "	
White pepper	⅛ "	2 "	

Cook the celery in the boiling water until very soft; strain and add the hot liquid; make a white sauce and cook until it is thick cream.

Cream-of-Potato Soup (Wegele).—

Potatoes, white	3 whole	300 gm.	450 calories
Milk	2 cupfuls	500 c.c.	340 "
Cream	½ cupful	125 "	220 "
Eggs	2 yolks	54 gm.	204 "
Salt	1 teaspoonful	4 "	
Pepper	½ "	1 "	
Onion juice	½ "	2 "	

Cook the potatoes until soft, drain, mash, add the hot liquid and strain; add the beaten yolks and seasoning. Cook in a double boiler until the egg thickens, stirring constantly. Serve immediately.

Tapioca Soup (Yeo).—

Meat broth or stock	1 pint	600 gm.	454 calories
Previously washed tapioca	¾ ounce	21 "	21 "

Boil the broth or stock, and, while stirring constantly, sprinkle in the tapioca. Cover the saucepan, and let it stand until the tapioca is quite soft. Skim and serve.

Julienne Soup (Vegetarian) (Watson).—

Vegetable stock (clarified)	1 quart	1,000 c.c.	360 calories
Mushroom ketchup	2 tablespoonfuls	30 "	
Salt and pepper	½ teaspoonful	2 gm.	
Turnip, carrot, celery, onion	4 ounces, each	400 "	160 "
Walnut ketchup	2 tablespoonfuls	30 c.c.	
Sherry	½ cup	120 "	160 "

Cut the vegetables into fine strips about the size and shape of a small match, and boil them separately until tender but not broken. Have the

stock ready boiling; add salt, pepper, a very little ketchup and sherry to taste; put in the prepared vegetables, cook for fifteen minutes and serve.

White Soup (Watson).—

Onions	2 small	200 gm.	84 calories
Celery	1 head	200 "	32 "
Milk	½ pint	250 c.c.	170 "
Turnip	1 whole	560 gm.	24 "
Artichokes	2 French	720 "	194 "
Flour	1 dessertspoonful	15 "	15 "
Potatoes (white)	1 pound	550 "	385 "
Water	3 pints	1,500 c.c.	
Butter	1 ounce	30 gm.	240 "

Cut about 2 pounds weight of any white vegetables, wash and peel and cut in pieces and boil until soft in the water; salt and butter. Rub them through a sieve or colander, put them back in the stewpan with the milk, and let it boil. Put in the flour, mixed smoothly with cold water, let the soup boil for ten minutes and serve with slices of fried bread.

Clear Soup or Consommé (Watson)(5).—

Soup stock	1 quart	1,000 c.c.	360 calories
Lean, juicy beef	½ pound	260 gm.	700 "
Sugar	1 lump	10 "	41 "
Egg	1 whole	50 "	80 "

The stock should be in the form of a good jelly.

Method: Carefully remove all fat from the top of the stock, and put it into a clean lined saucepan. Wipe the beef with a damp cloth, and shred it finely as you would for beef tea, removing all fat and skin. Add this to the stock, with the white of the egg and the shell, well washed and crushed. Whisk these over the fire with a wire whisk until the soup just comes to the boiling point. Then remove the whisk, and let the soup boil up. Draw the pan to the side of the fire, where the soup will keep warm but not simmer, and cover it with a plate. Let it stand there from ten to fifteen minutes. Tie a clean cloth on to the four legs of a chair turned upside down, letting it fall slightly in the middle so as to form a bag. Pour some boiling water through the cloth into a basin to heat the cloth thoroughly. Then strain the soup. It will not be clear the first time, so change the basin and pour the soup through again, repeating this process until it is quite clear. In repeating, add a lump of sugar, which makes the soup sparkle.

This soup can be varied by the addition of different garnishes, *e.g.*,

Consommé and Egg (Watson).—

Consommé	1 quart	1,000 gm.	110 calories
Egg	1 (whole)	50 "	86 "

Put the clear soup into a saucepan, and bring it to the boil. Beat up the egg in a small cup or basin with a fork, and pour it slowly into the boiling soup, stirring all the time with a spoon. The egg will curdle in the soup, and look like threads of yellow.

Lentil Soup (Watson).—Wash the lentils thoroughly in cold water, and add them to water in the proportion of ¾ pound lentils to a gallon of water or of second stock. Add pepper, salt, onion, turnips, carrot and celery. Boil all for three or four hours. Pass through fine wire sieve or colander, put on a few minutes to heat, and send to table with toast cut in dice. A little curry powder may be added if desired. This soup is somewhat apt to cause flatulence in those of weak digestion, but if made with Benger's pancreatized lentil flour and without the additional vegetables, it will be found very acceptable to the most delicate stomach. Pea soup served with dried mint, and haricot bean soup can be made in the same way. Fuel value, 100 grams, 130 calories.

Brunoise Soup (Watson).—

Carrot, young	1 (whole)	100 gm.	18 calories
Turnip, young	½	140 "	6 "
Celery	2 leaves	20 "	3 "
Flower of small cauliflower	1 small	10 "	1 "
Onion	1 (whole)	100 "	42 "
Butter	1 ounce	30 "	240 "
Milk	1 pint	500 c.c.	350 "
Water	1 "	500 "	
Salt	1 teaspoonful	4 gm.	
Pepper	¼ "	1 "	
Stale bread, toasted	2 ounces	60 "	200 "

Stew the ingredients together, except the toast, for one hour, then break the toast in pieces, add it to the rest, and stew all together for another hour. Pass all through a sieve and return to the stewpan to heat.

Potato Soup (Watson).—

Potatoes	1 pound	550 gm.	385 calories
Leek	1 (medium)	100 "	40 "
Onion	1 "	100 "	42 "
Butter	1 ounce	30 "	240 "
Milk	1 pint	500 c.c.	340 "
Water	1 "	500 "	

Stew the potatoes, put them with leek, onion and butter into a pint of boiling water in a stewpan. Boil until the vegetables are soft, then pass them through a sieve, adding a pint of hot milk. Put the mixture into the stewpan until it boils. Serve with dice of fried bread.

Brown Vegetable Soup (Watson).—

Water	2 quarts	2,000 c.c.	
Butter	1 ounce	30 gm.	240 calories
Bread	1 slice	37 "	99 "
Onions	2 (whole)	200 "	84 "
Cabbage	1 pound	550 "	145 "
Potatoes	2 (whole)	300 "	304 "
Carrots	2 "	200 "	36 "
Turnip	1 (large)	280 "	12 "
Parsley, salt and pepper.			

Fry a slice of onion in a large saucepan. When it is brown, but not burned, add water, salt and pepper, bread toasted and vegetables cut into small pieces. Boil three or four hours, then rub the vegetables through a colander and boil again for ten minutes, when the soup is ready. If too thick, add a little more water.

MEAT SOUPS

All soups, bouillons and broths consist principally of salts and extractive substances. They merely serve as appetizers by exciting the gastric secretions, and have very little nourishing or caloric value. In atony of the stomach, hypersecretion and general hyperesthesia, bouillon is contra-indicated, as it increases gastric secretion. During hot weather, on account of its tendency to fermentation, bouillon should always be freshly prepared. Beef tea is much more nutritious than ordinary bouillon, and freshly made beef juice is much more nourishing than any of the other preparations.

General Directions for Soupmaking.—In order to expose as large a surface to the water as possible, the meat is cut up into pieces, while the solvent power of the water is increased by the addition of a little vinegar. The temperature is kept at a little below 160° F. for several hours. As vegetables require a very much greater heat than this to soften them, they should either be first boiled, and then the meat should be added, or the vegetables can be cooked separately, and only added to the soup when it is almost ready. This preserves the color best. Flavoring herbs should be put in at the last moment. In all soups made from meat, great care should be exercised in the removal of the fat. This is done by making the

soup the day before it is required, putting aside in a basin to cool, and when it is quite cold carefully skimming the fat from the top.

First Stock for Clear Brown Soup (Watson).—

Shin of beef	1 pound	550 gm.	600 calories
Knuckle of veal	1 "	550 "	615 "
Cold water	3 quarts	3,000 c.c.	
Carrot	1 (whole)	100 gm.	18 "
Turnip	1 "	140 "	6 "
Mixed herbs	1 teaspoonful	4 "	
Small onions	2 (whole)	200 "	84 "
Celery, or	2 or 3 stalks	55 "	101 "
Celery seed	1 teaspoonful	4 "	8 "
Peppercorns	2 dozen	2 "	2 "
Cloves	8 seeds	12 "	2 "
Mace	1 blade	12 "	2 "
Parsley	A few stalks	100 "	4 "
Salt	1 dessertspoonful	8 "	

Wipe the meat with a damp cloth, and remove all marrow from the bone. Take a very sharp knife and cut the meat into small pieces, keeping back any fat, but using the skin. Put the bones and meat into a stock pot with the cold water and salt, and let them soak for half an hour, then put the pot on the fire, and bring the contents slowly to the boil. Simmer for half an hour, and then remove any scum that may be on the top. Add the vegetables, prepared and cut rather small, and the herbs, celery seed, and peppercorns, etc., tied in a small piece of muslin. Simmer slowly from four and a half to five hours, never letting it go off the boil. Then strain through a hair sieve or cloth stretched over a colander, and let stand until cold. A darker colored stock may be obtained by frying the meat in a little dripping or butter before pouring on the water.

Do not throw away the meat or vegetables left after straining, but put them on again with the same quantity of water as before, and boil again for second stock.

Fish Soup (Watson).—

Small haddock or whiting, or piece of cod	4 ounces	100 gm.	108 calories
Butter	½ ounce	15 "	120 "
Flour	½ "	15 "	15 "
Cold water	1 pint	500 c.c.	
Milk	1 gill	166 "	120 "
Egg	1 yolk	18 gm.	68 "
Cream	½ gill	80 c.c	139 "
Finely chopped parsley	1 teaspoonful	4 gm.	2 "

Wash and scrape the fish very clean. See that there is no black skin lining the inside parts. Remove the eyes. Cut the fish across into several pieces, and put them in a lined saucepan, cover with cold water and add the salt. Bring to the boil and skim. After the fish has boiled for a few minutes, pick out a few of the best pieces of fish, free them from skin and bone, and reserve them for serving in the soup. Allow the rest to simmer from three-quarters to one hour. Then strain through a wire sieve, and rub some of the white pieces through. Rinse out the pan the soup was cooked in. Melt in it the butter, add the flour, and mix these two smoothly together, being careful they do not brown. Then pour on the soup and stir until boiling. Beat the yolk of egg and cream and milk together, and, when the soup is off the boil, beat these ingredients into it. Strain through a fine strainer, stirring all the time. Do not let the soup boil after the egg is added, or it will curdle. The pieces of fish that were reserved and the chopped parsley are now added.

Egg Dumpling Soup (Wegele).—

Eggs	2 (whole)	100 gm.	160 calories
Flour	(¼ ounce)	7 "	6 "

Thoroughly mix the yolk of the eggs with the flour. Beat stiff the whites of two eggs and add to above. Drop the dumplings into the soup with a teaspoon, and allow the soup to boil up once or twice. Take out the dumplings carefully with a skimmer, so they will not break, put into the soup plate and then add the soup.

Oyster Stew (Fitch).—

Milk	1 cupful	250 c.c	170 calories
Oysters	1 pound	453 gm.	230 "
Salt	¼ teaspoonful	1 "	
Butter	1 tablespoonful	15 "	120 "
Pepper	¼ saltspoon		

Heat the milk. Cook and strain the oyster juice. Add the oysters, which have been rinsed, and cook until the edges curl. Add seasoning, butter and hot milk. Serve at once. This soup may be thickened with a tablespoonful of flour cooked in the butter.

Sweetbread Soup (Wegele)(6).—The sweetbread is soaked in cold water for one hour, the water being renewed frequently during this time. It is then boiled for one hour in slightly salted water or beef broth, to which may be added one teaspoonful of julienne to improve the taste. After it is soft, the sweetbread is taken out of the broth and all blood vessels and skin are removed. It may then be cut into pieces the size of

a walnut and put on a plate, over which the broth is poured, or the sweetbread may be forced through a sieve, the beef broth poured over this, and the whole put on the fire again until it boils, after which the soup may be served. This latter process is to be recommended in the case of dyspeptics. One hundred drams of raw sweetbread generate about 90 calories of heat.

Oyster Soup (Watson).—

Oysters	1 dozen	170 gm.	88 calories
Fish stock or white stock	1 pint	250 c.c.	100 "
Butter	1 ounce	30 gm.	240 "
Flour	1 "	30 "	30 "
Cayenne	a pinch	0.2 "	
Cream	4 tablespoonfuls	160 c.c	278 "
Egg	1 whole	50 gm.	80 "
Anchovy essence	a few drops		
Lemon juice	a squeeze		
White pepper and salt			

Place the oysters in a small saucepan with their own liquor, bring them almost to the boil, then strain. Beard the oysters (that is, remove the piece like a fringe that encircles them), cut them in two, and put them aside for stewing in the soup. Put the beards into a saucepan with the liquor and the stock, and let them simmer for half an hour to extract all the flavor from them. If the stock is not previously well flavored, small pieces of the different flavoring vegetables[1] should also be cooked in it. Strain through a fine hair sieve or piece of muslin, and rinse out the saucepan ready for use. First melt in it the butter, being careful it does not brown, add to it the flour and mix together until quite smooth. Pour on the stock, and stir constantly over the fire until boiling. Skim if necessary. Season to taste with a little white pepper, salt, anchovy essence, and pinch of cayenne. Beat up the yolk of eggs in a basin with the cream and strain into the soup. When off the boil, stir all the time. Place oysters in the soup tureen, pour the soup over them and serve.

FARINACEOUS FOODS

Boiled Rice (U. S. Army Hospital Recipe).—

Rice	1 ounce	30 gm.
Salt		20 gm.
Water	4 ounces	

Put the salt and water into a stewpan. When boiling add the rice, previously washed thoroughly. Boil for ten minutes, or until each grain

[1] Volume I, Chapter XVII, page 640.

becomes soft. Drain it on a colander. Grease the stewpan with clarified drippings or lard. Put back the rice. Let it swell slowly near the fire, or in a slow oven, for about twenty minutes, until the grains are well separated.

Boiled rice furnishes 60 calories to 1 tablespoonful.

Cornmeal Mush (*Individual Rule*) (Pattee).—

Cornmeal	1 ounce	30 gm.	100 calories
Flour	½ tablespoonful	15 "	40 "
Salt	¼ teaspoonful	1 "	
Cold milk	¼ cupful	30 c.c	40 "
Boiling water	½ "	125 "	

Mix the meal, flour and salt with the cold milk or water; when smooth, stir into the boiling water. Cook in a double boiler one hour or more, or over direct heat one-half hour. Serve with cream and sugar. If wanted for sautéing turn into tins to cool. Cut into slices, dip in flour and sauté in drippings or butter.

Hominy Mush (Pattee).—

Fine hominy	¼ cupful	30 gm.	100 calories
Salt	¼ teaspoonful	1 "	
Boiling water	1⅛ cups	333 c.c.	

Put all the ingredients together in a double boiler and cook two hours. Add more water if mush seems stiff and thick. All preparations of corn absorb a great deal of water in cooking, and hominy usually needs a little more than four times its bulk.

Note.—Hominy is exceedingly indigestible unless well cooked, but sweet and nutritious when subjected to a high temperature for a long time.

Oatmeal Mush for Children and Invalids (Pattee).—

Granulated oatmeal	1 cupful	453 gm.	380 calories
Salt	1 teaspoonful	1 "	
Boiling water	1 scant quart	1,000 c.c.	

Put the oatmeal and salt in a double boiler, pour on the boiling water, and cook three or four hours. Remove the cover just before serving, and stir with a fork to let the steam escape. If the water in the lower boiler be strongly salted, the oatmeal will cook more quickly. Serve with sugar or salt and cream or milk.

Note.—Baked sour apples, apple sauce and apple jelly are delicious eaten with oatmeal. They should be served with the mush, and sugar and cream poured over the whole. They give the acid flavor which so many

crave in the morning. Coarse oatmeal is not advisable in any form of water brash, acidity or bowel irritations. It often causes eruptions on the skin in warm weather.

Rice and Macaroni (Watson).—These carbohydrates are the basis of many nourishing and easily digested Italian dishes. In cooking, the directions for boiling rice and macaroni should be closely followed.

Plain Boiled Rice (Watson).—Wash well some Patna rice in several waters until the last water looks quite clean. If there is a pot for steaming the rice in it is best to use this, but if not, boil the rice in a saucepan of boiling water containing salt, which is in the proportion of one teaspoonful to the quart. Boil quickly with the lid off, stirring it frequently with a fork to prevent it sticking to the pan. Cook from ten to fifteen minutes until the grain will rub down easily when tested between the finger and thumb. Strain through a sieve or strainer, and dry the rice either by putting it into the saucepan by the side of the fire, or putting it on a plate in a moderate oven. While drying, stir lightly with a fork every now and then to keep the grains separate. The water in which the rice has been boiled contains the best part of the rice, so it should not be thrown away, but kept for the stock pot.

Italian Rice (Cheese and Rice) (Watson).—Boil the rice as directed above, strain and pour back into a pan. Put a sufficient quantity of butter into a frying pan; when the butter is melted add the rice, and mix well together for two or three minutes. Place the rice in a dish and cover with grated Parmesan cheese.

Boiled Macaroni (Watson).—Break the macaroni into short lengths, and throw it into a saucepan of freshly boiling water with salt in it. Boil quickly, with the lid off, until it has thoroughly swelled and is tender. Stir occasionally, to prevent it sticking. The time depends on the variety of the macaroni—the large pipe will take about half an hour, the small much longer. Keep it well covered with water. When done, drain. Boiled macaroni may either be served plain with meat, or it may be put back into the saucepan with enough stock to cover it and allowed to stew for half an hour. The pulp of a fresh tomato rubbed through a sieve may also be added.

Farina Dumplings (1) (Wegele).—

Farina	2 ounces	60 gm	200 calories
Boiling milk	¾ pound (1½ pints)	750 c.c	510 "
Egg	1 (whole)	50 gm	80 "
Butter	½ ounce	15 "	120 "

Pour the farina slowly into the boiling milk to avoid its getting lumpy. When thick, take off the fire, add the egg, and put back on the fire, but do not let the farina get too hot. Dip a flat spoon into the melted butter, and with this drop the farina into the hot milk a spoonful at a time. Place the dumplings on a dish and serve at once.

Farina Dumplings (2).—

Butter	1¾ ounces	50 gm.	384 calories
Boiling milk	2½ pints	1,250 c.c	850 "
Salt	a little	1 gm.	
Farina	½ pound	260 "	800 "
Eggs	5 (whole)	250 "	400 "

Put the butter into the boiling milk, add a little salt and the farina. Boil until stiff. Let the mixture cool off and add the eggs. Drop the dumplings into boiling water with a spoon, and let them boil for about one-quarter hour. This portion is large enough for four persons.

Farina Dumplings (3).—

Farina	½ pound	260 gm.	800 calories
Milk	1 pound (2 pints)	1,000 c.c	680 "
Eggs	6 (whole)	300 gm.	480 "
Salt	a little	1 "	
Bread or rolls	2 slices	75 "	200 "
Hot butter			

Boil the farina in the milk until soft. Let it cool off, and add the eggs and the salt. Cut the bread or rolls into small squares, roast in hot butter, add to the farina and mix well. Put everything into a pudding dish and let it steam for one hour.

Potato Dumplings (Pattee).—

Grated potatoes	20 tablespoonfuls	1,000 gm.	1,120 calories
Butter	1¾ ounces	50 "	384 "
Eggs	3 (whole)	150 "	240 "
Salt	a little	1 "	
Farina	1¾ ounces	50 "	180 "

Boil the grated potatoes the day before using and mash thoroughly. Add the butter, mixing thoroughly; also the yolks of the eggs, stirring in one after the other with a little salt. Previously boil the farina in milk until it thickens; let cool a little. Beat the whites of the eggs, mix and finally add the grated potatoes. Dip the hands into flour and form lengthwise dumplings; boil in salt water for 15 to 20 minutes.

BREAD(7)

Drexel Institute Bread Recipe.—

Warm milk or water	2 cupfuls	500 c.c	340 calories
Salt	2 teaspoonfuls	8 gm.	
Sugar	2 "	20 "	82 "
Lard or butter	1 tablespoonful	15 "	120 "
Compressed yeast	½ cake	4 "	
Flour	4 pounds	2,000 "	6,500 "

Put the water or milk, salt, sugar and fat into a bowl. Gradually add the yeast, dissolved in warm water, and the flour. When stiff enough to handle, turn the dough on a floured board and knead until soft and elastic. Put it back into the bowl, and let it rise in a warm place until it is double its bulk. Then divide it into loaves or shape into biscuits. Put these into the pan in which they are to be baked, cover them and again allow the bread to rise to double its bulk. Bake loaves one hour in a hot oven. The large amount of yeast allows the bread to be made and baked in three hours. This recipe makes two loaves.

Brown Bread.—

Scalded milk	½ cupful	125 c.c	85 calories
Water	½ "	125 "	
Salt	1 teaspoonful	4 gm.	
Butter	½ tablespoonful	7 "	65 "
Lard	½ "	7 "	65 "
Molasses	2 tablespoonfuls	30 "	148 "
White flour	½ cupful	275 "	800 "
Graham flour	1 "	553 "	1,600 "
Yeast	¾ cake		
Lukewarm water	¼ cupful	60 c.c.	

Take the above ingredients and sufficient Graham flour to knead, dissolving the yeast in the lukewarm water. Prepare the same as white bread. Instead of Graham flour, equal parts of Graham flour and white flour may be used in kneading.

Nut Brown Bread.—The same as preceding, with one cupful of nuts chopped and added.

Whole-wheat Bread.—

Yeast	¼ cake	1 gm.	
Lukewarm water	1 tablespoonful	15 c.c.	
Hot water	½ cupful	125 "	
Milk	½ "	125 "	85 calories
Salt	½ teaspoonful	2 gm.	
Whole-wheat flour	1 cupful	553 "	1,624 "

Dissolve the yeast in the lukewarm water. Pour the hot water over the milk, and when lukewarm add the yeast and salt. To this add the flour, and beat for five minutes. Cover and allow this to stand in a warm place for two hours and a half. Then add the whole-wheat flour gradually, mixing the mass until it can be kneaded. Knead until elastic; shape and place in baking pans. Cover and allow to stand in a warm place until it doubles its bulk. Prick the top with a fork, and bake for one hour. The oven should not be hot as for white bread.

Pulled Bread.—Use bread made with water. Make into long loaves, and as soon as baked take off the crust. Pull into stick-shaped pieces and brown slightly in a slow oven.

Zwieback.—Cut stale bread in slices and place in the oven and allow to remain until the slice is colored golden brown. Zwieback is a particularly desirable food for infants and invalids.

Bran Muffins for Constipation (Musser and Piersol).—

Bran flour	2 cupfuls	500 gm.	100 calories
Wheat flour	2 "	1,000 "	3,200 "
Buttermilk	1 cupful	250 c.c	80 "
Molasses	4 tablespoonfuls	60 gm.	200 "
Salt	a little		

Bake in muffin pans (one to be taken at each meal).

Graham Bread (Pattee) (8).—Make the same as whole-wheat bread, adding two tablespoons of sugar or molasses. Make a batter with white flour, using three or four cups, then use whole wheat or graham flour. Let rise longer than for white bread, and put immediately into pans without second kneading. Bake in a hot oven from forty-five minutes to one hour, depending upon size of loaves. If hard crust is desired, remove from pans and cool in a draft of air. For soft crust, before bread cools, roll it in a clean cloth.

Note.—Omit sweetening if desired.

White Gems (Pattee).—

Flour	2 cups	550 gm.	1,600 calories
Salt	1 teaspoonful	4 "	
Rumford baking powder	4 teaspoonfuls	16 "	
Butter	2 tablespoonfuls	30 "	240 "
Sugar	2 "	40 "	160 "
Eggs	2 (whole)	50 "	160 "
Milk	1 cupful	250 c.c	170 "

Sift dry ingredients into mixing bowl, add melted butter, and rub it in with tips of fingers. Add the well-beaten eggs and the milk gradually and beat all well together. Have gem pans well greased and heated; fill two-thirds full, and bake in a very hot oven fifteen or twenty minutes. Put a little melted butter on each gem before putting it into the oven. They are sufficiently cooked when, if tested with a fine washed knitting needle, it comes out dry.

Cornmeal Gems (Pattee).—

Flour	1 cupful	265 gm.	800 calories
Cornmeal	½ "	130 "	380 "
Sugar	⅓ "	100 "	400 "
Rumford baking powder	4 teaspoonfuls	16 "	
Salt	½ teaspoonful	2 "	
Egg	1 (whole)	50 "	80 "
Milk	1 cupful	250 c.c	170 "
Melted butter	1 tablespoonful	15 gm.	120 "

Sift dry ingredients into mixing bowl, add the milk and well-beaten egg and the melted butter. Put into well-greased hot gem pans and cook in a quick oven.

TOAST (Pattee)

In the ordinary cooking of a loaf of bread, the starch, in the outer layer, is changed into dextrin, which gives the crust its sweet flavor. Slices of bread toasted undergo a similar change. Bread is toasted not merely to brown it, but to take out all the moisture possible, so that it may be more thoroughly moistened with the saliva, and thus easily digested; also to give it a better flavor. The correct way to make toast is to use stale bread cut in uniform slices, and to dry it thoroughly before browning. Toast which is prepared in this way, even if moistened with milk or water, may be very easily and thoroughly acted upon by the digestive fluids.

Milk Toast (Pattee).—Put a cup of rich milk in a saucepan and place it on the stove. While it is heating, toast three slices of bread to a delicate brown, and put them into a covered dish. When the milk is scalding hot, season it with a saltspoon of salt, and pour it over the toast. This furnishes 388 calories.

Note.—A little butter may be spread on each slice before the milk is added, but it is a more delicate dish without it.

Cream Toast (Pattee).—

Butter	½ tablespoonful	7 gm.	80 calories
Flour	½ "	7 "	50 "
Salt	½ saltspoon	1 "	
Cold water	1 tablespoonful	15 c.c.	
Milk	½ cup	125 "	80 "
Toast	1½ slices	37 gm.	75 "

Scald milk. Mix flour and salt and add the cold water gradually, making a smooth, thin paste. Add to scalded milk; cook in double boiler twenty minutes, stirring constantly until it thickens. Add butter. Pour over toast and serve hot on hot platter.

CEREAL FOODS

Either the grain itself or the specially prepared flour may be used. When the grains are used they should be spread on a clean table and all foreign substances removed. If the whole grains be used, it is well to wash them after picking them over, with two or three changes of cold water.

Cereals are best cooked in a double boiler. The lower part should be filled about one-third full of water, and, if more is added during the cooking, it should always be boiling hot. The cereal should be cooked over the fire for ten or fifteen minutes. The water should be boiled first and then salted. The cereal is added gradually, and the whole stirred to prevent it from burning. It should then be placed in a double boiler and steamed until thoroughly cooked. Cereals, like other starchy foods, require thorough cooking. Most recipes allow too short a time. Oatmeal, especially, develops a better flavor if cooked for three hours or more, and it is better when it is prepared the day before and reheated when used. It should be just thin enough to pour when taken out of the boiler, and when cooled should form a thin jelly.

Any cereal mush may be thinned with water, milk or cream and made into a gruel, or the gruel may be made directly from the grain or flour. Gruels should be thin, not too sweet nor too highly flavored, and served very hot. Milk gruels should be made in a double boiler. Gruels may be made more nutritious by the addition of whipped egg, either the white or yolk or both, and the various concentrated food products.

When cereal flours are used the flour should be rubbed to a smooth paste with a little cold water and added slowly to boiling water, stirring constantly until it is thoroughly mixed.

Cereals supply actual digestible nutriments to the body more cheaply

than any other class of foods, except the dried legumes. All animal foods, especially meats, are more expensive, even as sources of protein, than cereals. A glance at their composition shows that they are chiefly fuel foods, because of their high carbohydrate content. Their cost varies with the cost of labor and fuel in preparing the foods. The comparatively expensive ready-to-eat breakfast foods do not yield any extra nutritive value. Their only advantages are pleasant flavors and ease of serving. Cereal products yield on the average between 1,600 and 1,700 calories per pound.

LENGTH OF TIME TO COOK CEREALS

Cornmeal mush	Boil	10 minutes,	then	steam	for	3	hours	or	more
Oatmeal	"	10	"	"	"	"	4½	"	"	"
Irish oatmeal	"	10	"	"	"	"	8	"	"	"
Wheatena	"	10	"	"	"	"	2½	"	"	"
Gluten mush	"	30	"							
Steamed rice	"	1 hour								
Boiled rice	"	20 minutes, or until soft.								

GRUELS

Oatmeal Gruel.—

Granulated oatmeal	2 tablespoonfuls	45 gm.	184 calories
Table salt	1 saltspoonful	2 "	
Sugar	1 teaspoonful	10 "	41 "
Water (boiling)	1 cup	250 c.c.	
Milk	1 "	300 "	216 "

Mix the oatmeal, salt and sugar together, and pour on the boiling water. Cook for thirty minutes, then strain through a fine wire strainer to remove the hulls. Place again on the stove, add the milk and heat just to the boiling point. Serve hot. This gruel furnishes 425 calories.

Flour Gruel.—Proceed as in making oatmeal gruel, using, instead, two tablespoonfuls of wheat flour. Flavor with lemon juice, cinnamon, nutmeg or vanilla. Energy value about 400 calories.

Farina Gruel.—Proceed as in making oatmeal gruel, using, instead, two tablespoonfuls of farina, and boil but ten minutes before adding the milk. Energy value about 275 calories.

Imperial Granum Gruel.—As in the preceding, but use Imperial Granum instead of farina. Same caloric value.

Cracker Gruel No. 1.—

Cracker crumbs	2 tablespoonfuls	45 gm.	175 calories

Use the cracker crumbs and proceed as above. Cook only two or three minutes and do not strain.

Cracker Gruel No. 2 (Drexel Institute).—Brown the crackers, and reduce to a powder by means of a rolling pin. Add three tablespoonfuls of the powdered crackers to half a cupful of milk and half a cupful of boiling water. Cook for ten minutes, then add one-fourth of a teaspoonful of salt and serve. Energy value about 250 calories.

Racahout des Arabes (Gautier) (9).—This is a French preparation with a chocolate flavor which makes a most delicious gruel. A home-made raçahout may be made as follows:

Cocoa	1 pound	453 gm.	2,320 calories
Confectioner's powdered sugar	1 "	453 "	1,875 "
Rice flour	1 "	453 "	1,630 "
Arrowroot flour	2 ounces	56 "	60 "
Sugar of milk	2 "	56 "	224 "

Mix the above ingredients thoroughly. Follow the directions given for farina gruel.

Flour Ball.—Tie half a pint of flour in a square of fine cheesecloth, making a very tight ball. Place this in a pot of boiling water and cook for four or five hours. After taking out of the cloth, peel off the outside and grate the hard ball. Dry in the oven and keep in a covered jar. This is useful for making gruels for diluting milk for infants.

Flour Ball Gruel.—Proceed as for oatmeal gruel, using two teaspoonfuls of the above grated flour rubbed up in one-half cup cold water, and stirring into a pint of boiling water. Cook this for ten minutes. This will furnish 15 calories to 100 c.c.

Meal Soup.—

Wheat flour	2 tablespoonfuls	60 gm.	45 calories
Water	½ pint	250 c.c.	
Milk	½ "	250 "	170 "

This is prepared by browning the wheat flour in a clean frying pan, stirring continuously. The water and milk are brought to a boil, and a heaping tablespoonful of the browned flour is blended with water and then stirred into the mixture.

Cornmeal Gruel No. 1 (Pattee).—

Cornmeal	2 tablespoonfuls	60 gm.	45 calories
Flour	1 "	30 "	25 "
Sugar	1 teaspoonful	10 "	41 "
Salt	1 tablespoonful	4 "	
Hot water	1 quart	500 c.c.	
Milk	1 cupful	250 "	170 "

Proceed as in making oatmeal gruel, cooking in a double boiler for three hours.

Cornmeal Gruel No. 2.—Take a tablespoonful of cornmeal and moisten with a little cold water. Stir this into a pint of boiling water to which a pinch of salt has been added. Cook for three hours in a double boiler, or for thirty minutes directly over the fire. In the latter case it must be stirred constantly.

Gluten Gruel (Drexel Institute).—

Gluten flour	1 tablespoonful	30 gm.	30 calories
Cold water	¼ cupful	125 c.c.	
Boiling salted water	1 "	250 "	

Mix the gluten flour with the cold water and stir this into the boiling salted water. Cook directly over the fire for fifteen minutes, then add one clove and cook over boiling water for a half hour.

Barley and Oatmeal Jelly.—

From the Grain.—Prepare the grain as directed for barley water. Use from four to six tablespoonfuls of grain to the quart of water. Boil thoroughly for several hours until the grain is thoroughly cooked. Strain and cool. The jelly, when hot, should be just thick enough to pour. This furnishes about 28 calories to 100 grams.

From Prepared Flours.—Use two tablespoonfuls of the flour to a pint of water. Boil from fifteen to thirty minutes and strain.

Egg Gruel.—

Hot beef broth	1 cupful	250 c.c.	36 calories
Egg	1 (whole)	50 gm.	80 "
Salt	½ teaspoonful	2 "	

Take the beef broth made with "Soluble Beef," the egg and salt. Beat the white and the yolk of the egg separately, add the hot beef broth gradually to the yolk, stirring continually. Whip the white to a stiff, dry froth with the salt, and beat it into the hot broth. Return to the double boiler and reheat. Serve very hot.

Barley Gruel with Beef Extract.—

"Soluble Beef"	½ teaspoonful	2 gm.	20 calories
Hot water	2 cupfuls	500 c.c.	
Barley flour	1 tablespoonful	20 gm.	22 "
Salt	1 saltspoonful	2 "	

Dissolve the beef in the hot water, and mix the flour and salt together with a little cold water. Pour the boiling stock on the flour and cook for ten minutes. Strain and serve very hot.

Barley Meal Gruel (Watson).—

Barley meal	1 dessertspoonful	10 gm.	15 calories
Milk	½ pint	250 c.c.	170 "
Butter	Small piece	15 gm.	120 "
Sugar	1 teaspoonful	10 "	41 "
Salt	¼ "	1 "	

Mix the milk very gradually with the meal, stirring until quite smooth. Take a small lined saucepan, and after rinsing with cold water pour the barley and milk into it. Stir constantly over the fire until boiling, let it boil ten minutes, season and serve very hot.

Port Wine Gruel (Watson).—Make a gruel with oatmeal or barley meal and water, then thin it down with a glass of port wine; heat thoroughly, but do not boil again.

Arrowroot Gruel (*Individual Rule*) (Pattee).—

Arrowroot	2 teaspoonfuls	25 gm.	26 calories
Cold water	2 tablespoonfuls	15 c.c.	
Boiling milk	1 cupful	250 "	170 "
Salt	a pinch	1 gm.	
Sugar (lemon juice, wine or brandy as required)	½ teaspoonful	10 "	20 "

Blend the arrowroot and cold water to a smooth paste. Add to the boiling water or milk. Cook in double boiler two hours. Add salt. Strain and serve hot. Arrowroot is the purest form of starch, and beneficial in cases of diarrhea if not given too hot.

Barley Gruel (*Individual Rule*) (Pattee).—

Barley flour	1 tablespoonful	30 gm.	40 calories
Cold milk	2 tablespoonfuls	30 c.c.	24 "
Scalded milk	1 cupful	250 "	170 "
Salt.			

Blend the barley flour with the cold milk and stir into the scalding milk. Cook in double boiler twenty minutes. Season with salt to taste, and add sugar if desired. Strain.

Flour Gruel or Thickened Milk (*Individual Rule*) (Pattee).—

Scalded milk	¾ cupful	188 c.c.	128 calories
Cold milk	¼ "	62 "	42 "
Flour	½ tablespoonful	15 gm.	20 "
Salt	speck	1 "	
Raisins	1 dozen	8 "	20 "

Mix the flour with the cold milk to make a smooth mixture, and stir into the scalding milk. Cook in a double boiler one-half hour or on back

of stove in a saucepan. Stone and quarter the raisins, then add water enough to cover. Cook slowly until water has all boiled away. Add to gruel just before serving. Add salt. Strain and serve, or it may be eaten with the raisins in it. This gruel may also be made without the raisins. Never use raisins in bowel troubles.

Oatmeal Gruel (Watson).—

Coarse oatmeal	½ cupful	100 gm.	201 calories
Water	2 cupfuls	500 c.c.	
Salt	½ teaspoonful	2 gm.	
Milk	½ cupful	125 c.c.	85 "

Pound the oatmeal in a mortar until it is mealy, then put it into a tumbler and fill it with cold water. Stir, and pour off the mealy water into a saucepan. Fill tumbler again, stir and pour off, and repeat until the above quantity of water is exhausted. Boil the oatmeal water thirty minutes, stirring frequently. Season with salt to taste. Thin with milk or cream to desired consistency.

EGGS

Eggs are a very concentrated food, one egg being equal in nutriment to 40 grams, 1⅓ ounces of fat; or two eggs, equal to about 5 ounces of cow's milk. The digestibility of eggs is influenced by the mode of preparation. They are a rather fatty food and contain fat and albumin in about equal proportion, 5 to 6 per cent. Egg albumin is almost entirely peptonized in the stomach, and the fat of the yolk is almost completely split up before reaching the small intestine. Hard-boiled eggs are difficult to digest by weak stomachs, and may even be the cause of painful sensations for the reason that the coarse albumin, which is not readily dissolved, irritates the sensitive mucous membrane of the stomach; if taken in pulverized form they will cause no disturbance. Omelet soufflé and fried eggs are difficult of digestion, while soft-boiled eggs and poached eggs are more easily and readily digested. Eggs for the invalid or convalescent, whether partaken of raw or cooked, should be perfectly fresh. Eggs are a very nourishing food for children on account of the lecithin and phosphates.

Eggs are exceedingly valuable as a food for invalids. They should not be kept with any article of food having an odor, as they absorb such odors and the taste is thereby impaired. Stale eggs will not sink, and if held to a bright light they show a dark spot. The yolk of an egg that has

been broken may be kept fresh by placing it (unbroken) in a cupful of cold water. This should be set in a cool place. This will keep it fresh for twenty-four hours or more. Eggs and all other albuminous food should be cooked at as low temperatures as possible, in order to avoid rendering them tough.

Eggs are best cooked in the shell as follows:

Soft-cooked Eggs.—Place in a pint of boiling water, remove from the fire, and allow to stand for eight or ten minutes. If the egg is very cold to start with, it will take a little longer.

Hard-cooked Eggs.—Place in water, bring to a boil, and then set on the back part of the stove for twenty minutes. Eggs should be served as soon as cooked, and the dishes should be warmed and ready. One ordinary egg, 50 grams, 80 calories.

How to Make an Omelet (Watson).—Break the eggs into a bowl, add salt and pepper, and beat them with a fork for about a minute, not longer as a rule. When the eggs are sufficiently beaten they "run" off the fork in a homogeneous liquid, without any glutinous appearance. It is not necessary to beat for several minutes, with the idea that the more the eggs are beaten the lighter the omelet. This is a great mistake, as too much beating causes eggs to lose their consistency. It is, however, better to beat too much than too little. Place the pan on the fire to warm it, and put in a small piece of butter—about the size of a hazel-nut for an omelet of 2 or 3 eggs. Add the contents of the bowl when the butter steams. If this precaution is taken, the omelet will not catch, as the high temperature of the butter isolates the eggs. It is, therefore, a mistake to shake the eggs directly they are poured into the pan. But a second or two later, the fork must be passed round the sides of the pan to loosen the eggs, and then they are worked in all directions with the back of the fork as if they were scrambled. When they are sufficiently cooked, they look, in fact, almost like scrambled eggs; but now the omelet is shaken on to one side of the pan, and with the fork one-half is folded on the other and slid on to the dish. The shape of the omelet is thus obtained without difficulty, and the heat of one-half just finishes the cooking of the other as it rests upon it.

Omelet Soufflé (*Sweet*) (Watson).—

White sugar	1 tablespoonful	40 gm.	160 calories
Salt	a pinch	1 "	
Eggs	2 (whole)	100 "	160 "
Powdered vanilla	a little	¼ "	

Take two bowls; put into one of them 1 teaspoonful of white sugar, into the other a pinch of salt. Break 2 eggs, separate the yolks, and drop one yolk at a time into the bowl containing the sugar; whip them well with a wooden spoon until they become creamy like mayonnaise. Add a little powdered vanilla to another one-half teaspoonful of sugar, and mix with the yolks. Put the whites of the eggs into the bowl containing the salt, and whip into a stiff froth. Mix with the yolks as lightly as possible, and pour the contents into a buttered dish in the shape of a pyramid. Cover it with sifted sugar and leave it for three or four minutes on the side of the stove. Then put it into the oven for ten to twelve minutes, turning the dish occasionally to color it on all sides. Make two or three incisions with a knife, and serve immediately. This omelet must be eaten as soon as it is cooked, or it loses both its shape and its delicacy.

Snowball Eggs (Watson).—

Eggs	3 (whole)	150 gm.	240 calories
Powdered white sugar	1 tablespoonful	40 "	160 "
Milk	1 pint	250 c.c.	170 "
Rind of lemon or vanilla			
Sugar to taste			

Place 1 pint of milk in a saucepan on the fire with the rind of a lemon or a little vanilla, and sufficient white sugar to sweeten. Break 3 eggs, separating the white from the yolk. Beat the whites of the eggs into a stiff froth, adding a small pinch of salt. When sufficiently stiff, add the sugar and mix briskly. Take a teaspoonful of this mixture and throw it into the boiling milk in the saucepan; turn it three minutes later, remove it with a skimmer. Take as many spoonfuls of white of egg as remain and cook them in a similar manner, three or four at a time. (If the white has been beaten sufficiently stiffly, when cooked each spoonful will be a compact mass.) Arrange the snowballs in a pyramid on a dish. Pour the remainder of the milk from the saucepan into the yolks of the eggs; put this mixture into another saucepan on the fire, stir it constantly with a spoon, and let it thicken without boiling. Pass it through a strainer, and when cold pour it over the snowballs in the dish.

Prairie Oyster (Watson).—

Fresh egg	1 (whole)	50 gm.	80 calories
Vinegar	1 tablespoonful	15 c.c.	

Put the vinegar into a small cup and break the egg into it. Serve at once. This is a very digestible way of serving an egg, and it is very cool and refreshing.

Egg Drink (Watson).—

Egg	1 (whole)	50 gm.	80 calories
Milk	1 teacup	250 c.c.	170 "
Sugar	1 teaspoonful	10 gm.	41 "
Sherry wine	1 tablespoonful	15 c.c.	21 "

Beat up the egg, add to it the wine and sugar, beat together with a fork slightly, and strain through a fine wire strainer. Heat the milk in a small saucepan, and when almost boiling pour it on to the egg, stirring all the time. Serve hot. This can be made without wine, flavoring with cinnamon or lemon juice. The yolk of the egg only may be used, and soda water may take the place of milk.

Poached Egg (Watson).—

Egg	1 (whole)	50 gm.	80 calories
Boiling water	1 cupful	250 c.c.	
Lemon juice	1 teaspoonful	15 "	
Salt	a pinch	1 gm.	
Toast	½ slice	10 "	31 "

Break the egg into a cup, keeping the yolk whole. To a small saucepan of boiling water add a pinch of salt and a squeeze of lemon juice. Draw the water to the side, and when just off the boil slip the egg carefully into it. Cook slowly for three minutes, when the white should be quite set. Lift it out with a small fish slice or perforated spoon, and trim off any ragged edges of white. Place on a square of newly-made toast, and serve at once.

If required, this egg can be made richer by being served on buttered toast, or by having a little hot cream poured over it. A poached egg served on 2 tablespoonfuls of carefully prepared spinach is also a very nice dish.

Rumbled Egg (Watson).—

Egg	1 (whole)	50 gm.	80 calories
Milk	1 tablespoonful	15 c.c.	15 "
Pepper and salt	a pinch of each	1 gm.	
Butter	¼ ounce	7 "	60 "
Toast (dry)	a piece	10 "	31 "

Heat the milk in a small saucepan. Pour into the hot milk the egg beaten up in a cup with pepper and salt. Stir quickly over the fire until it begins to thicken, then remove it from the fire and continue stirring until it forms a creamy mixture. Put on a piece of newly-made toast,

and serve at once. If cooked too long, or allowed to stand, it becomes leathery and indigestible.

Poached Eggs with Cheese (Watson).—

Eggs	4 (whole)	200 gm.	320 calories
White sauce	1 gill		
Butter	7 ounces	30 "	240 "
Breadcrumbs	3 tablespoonfuls	65 "	250 "
Pepper and salt	a pinch of each	1 "	
Grated cheese	3 tablespoonfuls	60 "	273 "

Butter a flat dish and sprinkle it with half the breadcrumbs and cheese. Poach the eggs and place them on the top. Then pour over the sauce, and put the rest of the cheese and breadcrumbs on the top. Lay on a few small pieces of butter, and place in a hot oven to melt the cheese and lightly brown the top.

FISH

Fish contains a large quantity of protein and gelatinous substances. In the dietary of patients suffering from gastric disturbances, fish such as eel, salmon and herring should be excluded, the first two on account of the excess of fat contained, and the last on account of its excess in salts. The nutritive value of fish, generally speaking, is about equal to that of veal, and in the uric acid diathesis, fish is better borne than meat. Oysters are less digestible than is commonly believed(10).

Baked Fish (Watson).—

Uncooked butterfish	¼ pound	113 gm.	200 calories
Breadcrumbs	2 tablespoonfuls	45 "	175 "
Pepper, salt and a little lemon juice			
Egg	1 (whole)	50 "	80 "
Milk	½ gill	125 c.c.	85 "
Butter	½ ounce	15 gm.	120 "

Grease a small pie dish with a little of the butter. Have the fish free from skin and bone, and cut it into neat pieces. Lay half of these pieces in the bottom of the pie dish, sprinkle over them a little white pepper, salt and a squeeze of lemon juice, and then put on a layer of breadcrumbs. Next, put in the rest of the fish, seasoning and more crumbs. Beat up the egg in a basin, add the milk to it, and strain this into the dish. Put the rest of the butter in small pieces on the top and wipe round the edges of the dish. Bake in the oven until nicely browned.

Steamed Sole or Whiting (Watson).—

Whiting	1 pound	453 gm.	700 calories
Butter	1 ounce	30 "	240 "
Flour	1 "	30 "	22 "
Milk	1 gill	125 c.c.	85 "
Lemon	slice		

Skin and fillet the fish, wash and dry the fillets, and put them in a jam pot which is placed in a saucepan half full of boiling water. Cover tightly and let boil for ten minutes. Mix the butter with the flour in a saucepan over the fire. Add the milk and liquor from the fish, and cook for ten minutes, stirring well. Pour this sauce over the fillets and garnish with the lemon.

Steamed Fish (Watson).—

Haddock, whiting or sole	1 pound, filleted	453 gm.	340 calories
Salt and white pepper	a pinch of each	1 "	
Butter	½ ounce	15 "	120 "
Lemon juice	a squeeze		

This is the lightest and simplest mode of cooking fish for an invalid. Cut the fillets of fish into neat-sized pieces; grease a soup plate or muffin dish with a little butter, and place the fish on this. Sprinkle it with a little salt and white pepper if this is allowed, and squeeze over it some lemon juice, which helps to keep the fish firm and white. Cover with a piece of greased white paper, and then with a lid or basin. Place this over a pan half full of boiling water, seeing that the plate fits well on the pan. Keep the water in the pan boiling, so that there may be plenty of steam, and cook from twenty to thirty minutes, until the fish loses its clear, transparent appearance and looks quite white. If the pieces are thick, it is better to turn them while cooking. The liquid that is on the plate when the fish is cooked is the juice from the fish, and should be served with it. Serve with a little plain cold butter and a piece of plain bread or toast.

Stewed Fish (Watson).—

Filleted fish, whiting, haddock, sole, plaice	1 (whole) 2 pounds	1,000 gm.	1,400 calories
Breadcrumbs	1 tablespoonful	22 "	80 "
Chopped parsley	1 teaspoonful	4 "	5 "
Milk	1 gill	125 c.c.	85 "
Butter	1 ounce	30 gm.	240 "
Pepper (white)	a pinch	0.5 "	
Cold water	1 gill	125 c.c.	

Wipe the fish with a damp cloth and cut it into small, neat pieces. Rinse out a lined saucepan with water, and place the pieces of fish in the bottom. Sprinkle over them a little salt and white pepper, pour in the milk and water, put the lid on the pan, and let the fish cook slowly by the side of the fire until it is ready, which will be in about fifteen minutes. Do not overcook, or the fish will be hard. Lift out the pieces of fish on to the plate on which they are to be served, and keep them hot. Add the breadcrumbs and the butter to the water and milk in the pan. Stir over the fire for a few minutes until the breadcrumbs swell and thicken the sauce. Sprinkle in the minced parsley, and then pour this sauce over the fish.

Fish are allowable for old people. The oily fishes—such as salmon, herring, mackerel—are the only ones that are apt to disagree with digestion, unless taken in small quantities. In addition to the usual methods of boiling, frying and baking fish already described, a variety of dishes may be made from this class of food that are found to be appetizing as well as quite satisfying.

Fish Baked in Batter (Watson).—

Uncooked fish, haddock or sole	¼ pound	113 gm.	90 calories
Flour	1 ounce	28 "	240 "
Milk	½ gill	65 c.c.	45 "
Egg	1 (whole)	50 gm.	80 "
Butter	½ ounce	15 "	120 "
Pepper, salt and lemon juice			

First make the batter, rub the flour through a wire sieve, to free it from lumps, and put it into a basin. Beat up the egg with a fork and add it to the flour; beat with a wooden spoon until quite smooth and free from lumps. Then add the milk and beat for a few minutes longer. The more the batter is beaten the lighter it will be.

Have the fish free from skin and bone, and cut into small pieces. Lay these in the bottom of a small greased pie dish, and season with pepper, salt and a squeeze of lemon juice. Pour the batter over them, and put the butter in small pieces on the top. Allow this to stand for a few minutes before cooking, as this gives time for the flour in the batter to swell, and makes it lighter when baked. Bake in a quick oven from twelve to fifteen minutes until well risen and nicely browned. Serve at once, as the batter quickly falls.

Fish Soufflé (Watson).—

Uncooked fish	¼ pound	113 gm.	90 calories
Butter	½ ounce	15 "	120 "
Flour	½ "	15 "	10 "
Fish stock or milk	½ gill	65 c.c.	45 "
Eggs	2 (whole)	100 gm.	160 "
Pepper, salt and lemon juice	a pinch of each		

First make a panada with the butter, flour and fish. This is done by melting the butter in a small saucepan, adding the flour and mixing until it is smooth with a wooden spoon. Then pour on the milk or fish stock, and stir until the mixture is thick and free from lumps and leaves the sides of the pan quite clean.

Scrape the fish down finely with a knife. Put the panada into a mortar with the fish, seasoning and yolks of eggs. Pound well together and rub through a sieve. Beat up the whites of eggs to a stiff froth, and stir lightly into the fish mixture with an iron spoon. Pour into a greased basin, which should be only half full. Cover with a greased paper. Steam for twenty minutes. When firm, lift it out and turn out on a hot plate.

Panned Oysters (Watson).—

Oysters (deep-sea)	6 (whole)	90 gm.	44 calories
Salt, pepper	a pinch of each	1 "	
Butter	½ ounce	15 "	120 "
Meat stock	1 teaspoonful	4 c.c.	4 "
Lemon	thin slice		

Place the oysters in a colander and pour cold water over them. Drain for ten minues, then place in a very hot iron pan, add the salt, pepper, butter and meat stock. Cook for a few minutes and serve the oysters garnished with the lemon.

Broiled Oysters (Watson).—

Oysters (large)	6 (whole)	90 gm.	44 calories
Salt and cayenne pepper	a pinch of each	1 "	
Heated beef juice	½ ounce	15 c.c.	15 "
Melted butter	½ "	15 "	120 "

Lay the oysters on a board and dry them, season with the salt and cayenne pepper. Have a gridiron thoroughly heated, place the oysters on the gridiron, and brown them on both sides. Serve on a very warm plate with the beef juice and melted butter poured around them.

POULTRY

The flesh of poultry or barnyard fowls is characterized by short muscular fibers and a minimum amount of fat. The birds coming under this classification have already been referred to at length in the chapter on "Animal Foods" (Volume I, Chapter XII, page 296). They have an abundance of white flesh, which is most easy of digestion, being tender and of a delicate flavor. A young, well-fed chicken is the most digestible of all animal foods. Short-legged fowls are more delicate in flavor. As for age, a one-year-old cock will be found too tough for roasting or braizing, and only suitable for stews or soups. The flavor and tenderness of the young cockerel are greatly improved by caponizing, which has already been described in the reference just given.

Chicken Salad (Pattee).—

Cut chicken	½ pound	225 gm.	465 calories
Cut celery	1 cup	250 "	85 "
Nicelle olive oil	1 ounce (2 tablespoonfuls)	28 "	121 "
Salt	1 saltspoonful	1 "	
Pepper	½ "	0.5 "	
Vinegar	1 tablespoonful	15 c.c.	
Mayonnaise	2 tablespoonfuls	42 gm.	187 "

Cut the cold chicken into small dice and cut the cleaned celery into small uniform pieces. Mix these together and pour over the oil. Mix well, then sprinkle with salt and pepper to taste; add the vinegar; blend and put in colander to drain; set in a cold place for two or three hours. Just before serving add the mayonnaise, put on a bed of lettuce and garnish. The above quantity is sufficient for six servings. Use mayonnaise, olives, celery leaves or white lettuce for garnishing.

Note.—Do not mince chicken.

Broiled Chicken (Watson).—

Small chicken	1 pound	453 gm.	890 calories
Butter	1 ounce	30 "	240 "
Pepper and salt	½ teaspoonful of each	2 "	

Prepare a young chicken for roasting, split it down the back, lay it open, and take only half at a time. Rub the piece of chicken over with a little butter to keep the skin from cracking, and season with pepper and salt. Grease the gridiron and make it thoroughly hot. Lay the chicken on it with the cut side down. Broil either on the top of or before a clear

fire for about half an hour. When cooked, lift on to a very hot plate and rub the rest of the butter over it. Serve with rolls of bacon round it. If broiling an older fowl it must be partially cooked first, either by boiling or roasting. It may be eaten with or without bread sauce.

Stewed Partridge (Watson).—

Partridge	½ pound	225 gm.	465 calories
Butter	½ ounce	15 "	120 "
Flour	1 teaspoonful	45 "	150 "
Mace	1 blade	0.5 "	
Lemon	½ with rind		
Pepper and salt	½ saltspoonful		

Cut the partridge into joints and take out the largest bones. Put the butter into a small stewpan. When it gets hot put in the best parts of the partridge and dry very carefully. Add to this a small bit of lemon peel, mace, pepper and salt, then add the flour and 1 teacupful of water, and the bones that were removed. When this boils up put on the lid, and let it stew slowly for three-quarters of an hour, or until tender. Take up the best bits on a dish and strain the gravy over them. All game is easily digested when cooked in this way.

Roast Poultry (Wegele).—It is best to buy fresh-killed poultry. Clean, remove feathers and hang in a cool place for at least one day; in the winter for 2 to 3 days. The roasted skin of poultry should never be served to those having stomach trouble, as it is very indigestible. A pound will contain about 890 calories.

Capons (Wegele).—Capons and pullets should be roasted with very little butter, as they contain a great deal of fat. Baste constantly and roast about one and one-half to two hours. A pound capon will yield about 1,465 calories.

Boiled Broilers and Squabs (Wegele).—Prepare the same as for roasting. Put into slightly salted, boiling bouillon with a handful of dry vegetables, and boil about one to one and a quarter hours. Very young pigeons or squabs will be done in three-quarters of an hour; also very young chickens or broilers. A pound broiler or squab yields about 1,430 calories.

Stewed or Potted Broilers and Squabs (Wegele).—Prepare broilers or squabs as for roasting. Cut into four equal parts, add a little salt, and stew exactly like stewed veal for about three-quarters of an hour. Sauce to be prepared the same as for stewed veal. Medium size average a pound. Caloric value about 1,290 calories.

MEATS

General Rules for Preparing Meat.—Meat must be weighed, trimmed, and wiped with a damp cloth. It should be removed immediately from the paper in which it has been wrapped and placed in a cool place. Only tender cuts of meat should be broiled, pan-broiled or roasted. When meat is to be cooked by any of these methods, it should first be seared, and then the temperature slightly lowered. By searing, the albumin on the outer surface of the meat is hardened, and the meat is thus cooked in its own juices.

Tough meat should be cooked in water. Boiling water hardens the albumin on the outer surface of the meat and prevents the juices from escaping. Meat should be put in boiling water and the water allowed to boil for ten or fifteen minutes, then the cooking should be allowed to proceed at a low temperature until the meat is tender. If the water bubbles it is too hot. Cooked in this way tough meat will become tender. The time required for roasting or cooking in water varies with the weight and quality of the meat (*see* Volume II, Chapter III).

Roast meat is more easily digested than boiled meat, provided the connective tissue has been made more soluble by hanging the meat up in the refrigerator for a few days before cooking, thereby bringing about a post-mortem lactic acid process. Meat rich in fat is acted upon with greater difficulty by the gastric juice than lean meat. For instance, calf's brain, although very soft, contains much fat and is not well tolerated by the invalid or convalescent. Venison, hare and deer meat have a less fat content than beef, but the disadvantage of tougher muscular fiber. Meat of young animals is more tender than that of old ones, and hence preferable. Mild smoked ham is very nourishing, and if there is no danger of trichinæ may be eaten with impunity uncooked.

Roasting.—Skewer the meat into shape. Place it on a rack in a meat pan, in the bottom of which pieces of fat from the meat have been placed. Put in a hot oven on the grate for ten minutes to sear the meat. If desired, it may be seasoned with salt and pepper. Then remove to the floor of the oven and baste every ten minutes until it is done.

Broiling.—Remove extra fat from the meat and grease the broiler with a part of the fat. Broil over a clear fire; sear, and then turn every ten seconds. Chops one inch thick should be cooked for five minutes. A steak two inches thick should be cooked for ten minutes. Season and serve on a hot platter.

Pan-broiling (Drexel Institute).—Remove all the fat from the meat. Heat a frying-pan very hot, but use no fat. Sear the meat on both sides, and then cook more slowly until it is done. Stand chops up on their edges to brown. Keep the pan free from fat. The time required for pan-broiling is the same as that required for broiling.

Beef Pulp (Caultey).—Scrape a piece of raw lean rump or sirloin steak with a fork or meat scraper until as much as possible of the muscular tissue has been obtained, separated from the tendinous parts. Pound it in a mortar to a pulp, and then rub it through a fine sieve. Season with pepper and salt. It may be taken in the form of sandwiches, or rolled up into small rissoles and lightly grilled or fried.

Very little of the nutriment of the meat is lost in this process.

Beef Quenelles (Watson).—

Beefsteak	1 pound	453 gm.	1,130 calories
Breadcrumbs	4 tablespoonfuls	32 "	45 "
Salt and pepper to taste	¼ teaspoonful of each	1 "	
Egg	1 (whole)	50 "	80 "
Stock	2 tablespoonfuls	30 c.c.	20 "

Pound the beefsteak, breadcrumbs, salt and pepper, egg and stock well in a mortar, rub through sieve, shape with tablespoons and poach in shallow pan for ten minutes in boiling water. Pour a gravy made of thickened beef tea round the quenelles and serve with sippets of toast. This is a very digestible dish, nutritious and readily absorbed.

Roast Veal (Wegele).—

Loin of veal	6 pounds	3,000 gm.	4,540 calories
Fresh pork	1 pound	450 "	2,780 "
Hot butter or hot beef fat	a little less than ½ pound	200 "	1,590 "

In summer veal must soak in sweet milk for one or two days, in winter about 2 to 4 days, to make it soft and tender. Before preparing the meat it must be thoroughly washed, the skin removed and the meat well salted. Lard the meat with fresh pork and roast in hot butter or hot beef fat, using the above number of grams. The roasting is the same as for other meats, but it must be well done and will take one and one-quarter to two hours.

If the bone is not removed, a good juice will come forth, and after the fat has been removed the addition of a little bouillon (no flour) will give a nice sauce.

Ordinary serving—100 grams, 174 calories.

Roast Venison (Wegele).—Roast in hot butter and baste frequently; one hour required for roasting, except for loin of venison, which is not so tender and will take two and one-half hours to roast. Sauce to be prepared same as the roast fillet sauce. Sour cream can be added to the sauce.

Ordinary serving, 100 grams, 240 calories.

Hamburger Steak (Wegele).—

Beef	½ pound	250 gm.	660 calories
Cold salted bouillon	4 tablespoonfuls	120 c.c.	13 "

Take a nice piece of beef, chop about 250 grams (a tumblerful), and add the bouillon. If bouillon is not available, use salted water. Fry the meat about ten minutes. Chopped veal can be prepared in the same way.

Stewed Sweetbreads (Wegele).—Cook the sweetbreads until very soft, remove skin, cut in halves, and put into hot butter sauce for 10 minutes before serving. The sauce is prepared in this way: Take a piece of butter, put it into a saucepan and let it melt, but not get brown. Add one tablespoonful of flour, stir, add enough cold bouillon and a little white wine so that after boiling there will be a thick sauce. The sauce will be easier to digest if, instead of butter, gravy from any roast meat is used, but the fat must be taken off first. Before serving, an egg can be added to the sauce.

Ordinary serving—80 to 100 grams, 135 to 150 calories.

RAW BEEF

General Method of Preparing Raw Beef.—Raw meat forms an excellent aliment, although it seldom appears on our tables in this form. Fick has shown that raw meat is digested three times more easily and quickly than cooked or even underdone roast meat. Raw meat is the food which agrees best with very delicate stomachs, with tuberculous individuals, tabetics, chlorotics and even with many children who are obliged to be weaned prematurely, but it is necessary to know how to choose and to use it methodically. Great care should be exercised in the selection of meat to be ingested in its raw state. The flesh of pigs should be avoided altogether, as it is too firm, and may transmit various parasites. Meat intended to be eaten raw should be freed of all fat, scraped and reduced to a pulp with the edge of a knife or a spoon handle, but not chopped. By scraping, the muscle fibers are separated from the tendons and aponeurosis. This scraping results in little balls of pulp which should be rolled into boluses about the size of a nut without other addition than a little salt or

perhaps a little cognac, rum, sugar or the gravy of meat roast. These balls of meat pulp ought to be swallowed by the individual without chewing.

Raw Meat with Milk and Sugar (Ringer).—

Rump steak	½ pound	250 gm.	660 calories
Sugar	2 lumps	12 "	50 "
Brandy	4 teaspoonfuls	60 c.c.	200 "
Milk	½ glass	250 "	170 "

Scrape the steak with a knife until all the pulp is removed, sweeten with sugar, breaking the lumps of sugar with the meat in a basin with a small wooden spoon. Add slowly as much milk as will make it about the thickness of arrowroot; flavor with brandy. If any fiber of the meat remains, strain through a gravy strainer. The mixture should be perfectly smooth.

Raw-meat Juice (Cheadle).—Add to finely minced rump steak cold water in the proportion of one part of water to four parts of meat. Stir well together, and allow it to stand for half an hour. Forcibly express the juice through muslin, twisting to get the best results.

Raw Beefsteak (Wegele).—Take a good piece of steak, cut a square piece the thickness of a thumb. Pound the meat well, salt on one side only. Put into frying pan, fry in fresh butter for one minute. Turn and baste with the juice of the meat and again fry only one-half minute. Serve at once on a hot plate; 100 grams (3¼ ounces) furnish about 130 calories.

Raw-beef Soup (Weir Mitchell).—

Raw beef	1 pound	450 gm.	1,200 calories
Water	1 pint	500 c.c.	
Strong hydrochloric acid	5 drops	0.35 c.c.	

This is made by chopping up the raw beef and placing it in a bottle with the water and hydrochloric acid. This mixture is allowed to stand on the ice over night, and in the morning the bottle is placed in a pan of water at 110° F., and kept at about this temperature for two hours. The soup is then placed in a stout cloth and strained until the mass that remains is almost dry. The filtrate is given in three portions daily. If the taste of the raw meat is objectionable, the meat may be roasted quickly on one side and the process completed in the manner previously described.

Succus Carnis (Meat Juice) (Pettenkoffer and Voit).—Cut up the meat into small bits, arrange in layers separated from one another by coarse linen, and then place in a powerful press. From each kilogram of

meat about 230 grams of a blood-red juice are obtained. This contains about 6 per cent of albuminates. Its taste is similar to that of raw meat; its flavor may be improved by the addition of salt and beef tea not hot enough to coagulate the albumin.

VEGETABLES

General Rules for Cooking Vegetables.—Wash thoroughly; pare or scrape if skins must be removed. Stand in cold water until cooked to keep them crisp and prevent their being discolored. Cook in boiling water; the water *must* be kept at the boiling point. Use two teaspoonfuls of salt with two quarts of water; put the salt into the water when the vegetables are partially cooked. The water in which vegetables are cooked is called vegetable stock.

Fresh green vegetables require less water than others. Cabbage, cauliflower, onions and turnips should be cooked uncovered in a large amount of water.

All vegetables must be drained as soon as tender. Season with salt and pepper and serve hot with butter or sauce. The color may be kept in green vegetables, such as spinach, by pouring cold water through them after draining.

Vegetables, according to analysis, are known to possess various mineral matters and the green vegetables more especially contain iron. For analysis and the mineral content of vegetables the reader is referred to the section of the book dealing with this subject (Volume I, Chapter XIX).

Cold vegetables may be used for salads or may be placed in a baking dish with one-half the quantity of sauce (2 cupfuls vegetables and 1 cupful sauce), covered with buttered crumbs and browned in a hot oven.

TIME-TABLE FOR COOKING VEGETABLES IN WATER

(Drexel Institute)

Potatoes	25–30 min.	Spinach	30–45 min.
Carrots	35–45 "	Celery	20–30 "
Turnips	45 "	Parsnips	30–45 "
Beets (young)	45 "	Green peas	30–40 "
" (old)	3–4 hrs.	String-beans	1–3 hrs.
Tomatoes	1–3 "	Lima beans	1 hr. or more
Onions	45–60 min.	Green corn	12–20 min.
Cabbage	45–60 "	Rice	20–45 "
Cauliflower	20–30 "	Macaroni	45–60 "
Asparagus	20–30 "		

Sauce for Vegetables.—

Butter	3 tablespoonfuls	45 gm.	360 calories
Flour	3 "	45 "	150 "
Salt	1 teaspoonful	4 "	
White pepper	a pinch	0.5 "	
Milk	1 cupful	250 c.c.	170 "
Stock	1 "	250 "	36 "

Asparagus (Wegele).—

Asparagus	1 pound	453 gm.	52 calories
Salted water	1 pint	500 c.c.	
Butter sauce	8 tablespoonfuls	120 "	240 "
Egg	1 yolk	18 gm.	68 "

Clean asparagus, remove skin, cut off the hard parts. Boil in the salted water for about one-half to one hour. Use enough water, otherwise the asparagus will lose its color. Serve with a butter sauce, adding the yolk of the egg. For sensitive stomach use only asparagus tips. One hundred grams (a little less than 1½ ounces) furnish about 20 calories.

Spinach (Wegele).—

Spinach	1 pound	453 gm.	110 calories
Butter	a lump	15 "	120 "
Flour and bouillon	a tablespoonful		47 "

Clean and wash spinach thoroughly, remove the stems and rinse in water several times. Put the spinach into boiling water and boil quickly. When soft, pour into a sieve and allow it to drain, then mash through the sieve. Put the butter into a saucepan. When dissolved, add the flour and bouillon, making a thick sauce. Keep it on the fire, stirring constantly. Add the spinach and boil all for about one-quarter hour.

Oyster Plant (Wegele).—

Oyster plant	1 pound	453 gm.	100 calories
Flour	1 teaspoonful	4 "	5 "
Water	1 pound (2 pints)	1,000 c.c.	
Vinegar	1 tablespoonful	15 "	
Butter, salt and bouillon	2 tablespoonfuls	30 "	140 "

Clean and wash the oyster plant thoroughly, cut into pieces the length of a finger. To the flour add the water and vinegar, stir until smooth and add the oyster plant. Put all into a colander, pour cold water over it and let drain. Put into a cooking vessel containing some butter, cover tight, add a little salt and a little bouillon from time to time while cooking. It takes three-quarters to one and a half hours to cook oyster plant until soft. One hundred grams (a little more than 1¼ oz.) furnish about 120 calories.

Green Peas (Wegele).—It is best to use canned peas of the very best quality. Empty the peas into a sieve, pour cold water over them and strain. Prepare with a little butter and salt and let them boil for about one-quarter hour, adding strong bouillon and a little sifted flour. The peas can also be mashed through a sieve. Split peas can also be used for this purpose. Purée of peas is considered best for those having stomach trouble. Let the dry split peas boil for about one-half hour. Two hundred and eighty grams furnish about 1,000 calories.

Carrots (Wegele).—Only small carrots should be used. Clean and wash them and cut them into lengthwise pieces; prepare like peas or oyster plant. The carrots can be served mashed. After they have been boiled, mash them through a hair sieve, dust with a little flour and boil until they become a thick mass. One hundred grams (a little less than ¼ pound) furnish about 120 calories.

String Beans (Wegele).—Young string beans are the best to use. Clean and wash them, break into inch lengths, and prepare like peas in butter and beef soup. If fresh beans are not in season, canned string beans can be used. One hundred grams (¼ pound) furnish about 40 calories.

Cauliflower (Wegele).—Clean and wash the cauliflower and cook like asparagus. Time required, about ½ hour. For those with stomach trouble use only the upper part, not the stems. One hundred grams (less than ¼ pound) furnish about 60 calories.

Mashed Potatoes (Wegele).—

Potatoes	1 pound	453 gm.	385 calories
Butter (fresh)	¾ ounce	20 "	150 "
Salt	a little	1 "	
Hot milk	2½ ounces	90 c.c.	52 "

Peel and wash the potatoes, cut into 4 parts, boil in a double boiler until soft. Put into a hair sieve, mash thoroughly, add the butter, salt and hot milk, put back on the fire and stir constantly until smooth and thick. Serve at once. Clear beef soup may be added instead of butter if so desired. One hundred grams (3½ ounces) furnish about 125 calories.

Cauliflower à l'Indienne (Watson).—

Cauliflower	1 pound	453 gm.	140 calories
White sauce	½ pint	250 c.c.	256 "
Grated cheese	2 tablespoonfuls	20 gm.	150 "
Cocoanut	1 tablespoonful	32 "	200 "
Curry powder	1 dessertspoonful		

Boil cauliflower twenty to thirty minutes until the stalk part is tender. Drain and place on a fireproof dish. Add the curry powder and the white sauce, cooling the cauliflower well. Sprinkle the cheese and cocoanut on top, and brown quickly in a good oven. Cauliflower *au gratin* can be made by increasing the amount of cheese and omitting the curry powder and cocoanut.

Tomato Savory (Watson).—

Tomatoes	6 small	600 gm.	138 calories
Tomato sauce	1 gill	125 c.c.	60 "
Curry powder	1 teaspoonful		
Red-currant jelly	1 "	8 gm.	28 "
Breadcrumbs	2 tablespoonfuls	30 "	60 "
Grated cheese	2 "	28 "	200 "
Butter	½ ounce	15 "	120 "
Pepper and salt	¼ teaspoonful of each	1 "	

Choose small firm tomatoes. Put into boiling water for a minute or two, lift them out, dry and peel them. Then grease a fireproof dish and place the tomatoes in it. Sprinkle them with half the crumbs and cheese, and a little pepper and salt. Add the curry powder and the red currant jelly to the tomato sauce, and pour this over the tomatoes. Put the remainder of crumbs and cheese on the top, then the butter in small pieces and bake in a moderate oven about twenty minutes. Serve hot.

Mayonnaise Dressing (Pattee).—

Mustard	1 teaspoonful	4 gm.	100 calories
Powdered sugar	2 teaspoonfuls	24 "	
Salt	1 teaspoonful (level)	4 "	
Speck cayenne.			
Eggs	2 yolks	36 "	136 "
Nicelle olive oil	1½ cups	316 "	2,900 "
Vinegar	2 tablespoons	30 c.c.	
Lemon juice	2 "	30 "	

(*Individual Rule*, ¼ of a recipe.)

Mix dry ingredients. add to yolks and mix thoroughly. Add a few drops of oil at a time until one-half cup is used, beating with egg beater or wooden spoon. Then add alternately a few drops of vinegar and lemon juice and the remainder of the oil, using care not to lose the stiff consistency. It should be a thick dressing and should not be added to food until just before serving. A tablespoonful represents about 190 calories.

Note.—Have all ingredients and utensils thoroughly chilled and place mixing bowl in a pan of crushed ice while blending.

Cream Dressing (Pattee).—

Butter	¼ pound (½ cup)	116 gm	900 calories
Flour	2 tablespoonfuls	30 "	30 "
Scalded milk	1 cupful	250 c.c.	170 "
Eggs	3 yolks	54 gm.	204 "
Eggs	3 whites	96 "	54 "
Mustard	1 teaspoonful	4 "	
Cider vinegar	1 tablespoonful	15 c.c.	
Salt	1 teaspoonful	4 gm.	
Vinegar	½ cupful	120 c.c.	
Sugar	½ "	116 gm.	465 "

(*a*) Melt butter in a saucepan, add flour and pour on gradually the scalding milk, cook thoroughly, stirring constantly. (*b*) Beat yolks in top of double boiler, add the mustard (dissolved in one tablespoon of vinegar), salt and vinegar. Pour (*a*) gradually on the egg mixture and cook over hot water until it thickens like soft custard, remove from fire, add the sugar, and fold in the stiffly-beaten white of eggs. Pour into glass fruit jar, cool and cover, and keep on ice. This dressing will keep a long time and is especially delicious to serve with fruit salads.

PURÉES

Chicken Purée (Watson).—

Roast chicken (whole)	4 pounds	2,000 gm.	3,500 calories
Onion, carrot	1 pound	453 "	217 "
Celery	2 leaves.		
Cream	½ gill	125 c.c.	227 "
Lemon juice	a few drops	20 "	
Sugar	small lump	10 gm.	41 "

Remove all the skin and bones from a roast chicken. Chop the meat and pound it in a mortar, and rub through a sieve. Take the bones of the chicken, boil for several hours with onion, carrot, celery and enough water to cover them. Strain through a sieve, and remove all the fat. Add the pounded meat and simmer until it is sufficiently thick. Add the cream, lemon juice and sugar.

Lettuce Purée (Wegele).—

Salad (Romaine preferred)	1 pound (2 or 3 heads)	453 gm.	60 calories
Butter	a piece	15 "	120 "
Flour	a little	15 "	15 "
Beef soup	½ cup	125 c.c.	25 "

Take the salad, using only the hearts. Separate the leaves, rinse in cold water, scald with boiling water, and let boil in salted water until soft.

Put into a colander and let drain, then mash thoroughly. Melt the butter, add the flour, not allowing it to brown, stir well, add the salad, also a little beef soup, and boil all for a few minutes. A little sweet or sour cream may be added, if permitted.

Endive Purée (Wegele).—

Endive salad	½ pound	225 gm.	45 calories
Butter	a piece	15 "	120 "
Flour	small spoonful	15 "	15 "
Salt	a little	1 "	
Clear soup	½ cup	125 c.c.	25 "

Use the tender stalks of endive salad, scald them two or three times with boiling water, so they may lose their bitter taste. Boil quickly in salted water until soft. Pour off the water and put cold water over it, drain again and squeeze the endive thoroughly. Chop the stalks and mash through a sieve. Melt the butter, add the flour, and allow it to brown. To this add the mashed endive, salt, and soup, and stir until it becomes a thick mass.

Red Cabbage Purée (Wegele).—Slice the cabbage on a slicing machine. Stew in butter and beef soup about 1 to 2 hours, until soft. Mash thoroughly and stew again, adding a little wine and a lump of sugar; also a pinch of flour.

FRUITS

Baked Apples (Pattee).—Wipe and core apples. Put in a shallow dish with one tablespoon water to each apple. More may be added during cooking if necessary. Put into the center of each apple two teaspoons of sugar. Bake in a hot oven twenty to thirty minutes, or until soft; baste with the sirup every ten minutes. A little nutmeg may be added to the sugar, and a few drops of lemon juice to each apple. Care must be taken that apples do not lose their shape and break. One medium apple, 150 grams, furnish 70 calories.

Apricot and Prune Sauce (Pattee).—

Prunes	5 large (¼ cup)	100 gm.	265 calories
Dried apricots	¼ cup	40 "	114 "
Cold water	1 cup		
Sugar to taste			

Wash fruit carefully, soak over night, and cook slowly for two hours. If cooked properly the fruit will need very little sugar, as the sugar in the fruit is developed by this method of cooking.

Orange (Pattee).—Select a large, firm orange, wash, cut and peel skin down in eight parts, leaving them connected to stem end of orange to form petals, and folding them under the pulp. Separate pulp in sections and put ice between petals before serving. One medium orange, 250 grams, furnishes 96 calories.

Pineapple (Pattee).—

Hawaiian pineapple	2 slices	100 gm	44 calories
Cherry	2 Maraschino		

Serve pineapple on small tea plate with cherry in center. To eat a slice of pineapple after a meal is quite in accordance with physiological indications, as pineapple juice contains a remarkable digestive principle similar to pepsin. It aids the work of digestion in the stomach, also in the intestinal tract. The Hawaiian pineapple comes in three forms—sliced, crushed and grated. The sliced pineapple is usually served just as it comes from the can. The crushed and grated are used like apple sauce and also in delicious made desserts and beverages.

Stewed Prunes (Pattee).—Wash and look over the prunes, cover with clear cold water, and allow them to stand on the back of the range over night. In the morning put the saucepan where they will cook slowly for four hours.

Note.—No sugar is needed as prunes are 18 per cent sugar, and by this manner of cooking are made very sweet. This simmering process renders them rich and juicy, while boiling toughens the skin. A little lemon juice is a pleasant addition. Prunes are a valuable nutrient, and their use as a laxative is scarcely second to figs. Three prunes, 60 grams, furnish 125 calories.

Stewed Figs (Pattee).—

Figs	½ pound	275 gm	737 calories
White sugar	¼ cup	30 "	120 "
Cold water	1 "	250 c.c.	
Juice of lemon	½	15 "	

Wash figs. Dissolve sugar in water, add figs and bring slowly to boiling point. Stew two and one-half hours. When tender, add lemon juice.

Note.—Cut figs in small pieces, cook very slowly so as not to add more water.

NUTS

Cooking of Nuts (Pattee).—Nuts are more often eaten raw than cooked. But the peanut is not considered palatable when raw, and the chestnut is indigestible unless the starch is cooked, when it becomes very easily digestible. Almonds are widely used in confectionery. Nuts may be used as staple articles of diet, in salad, soups, desserts, etc.

To insure the best utilization of nuts they must be thoroughly prepared for digestion by grinding or mastication. Nut butters offer much less resistance to digestion than raw nuts hastily eaten. On account of the high fat content, these products must be fresh, or the fat is likely to decompose (become rancid) and be irritating.

Digestibility.—Nuts have been considered very indigestible. This is due largely to improper mastication or other preparation for digestion; to the fact that they are a very concentrated food, and are often eaten when not needed. While nut protein, as nuts are ordinarily eaten, is not so easily nor completely digested as meat protein, there are experiments showing that, on the whole, they are as thoroughly digested as an ordinary mixed diet. No experiments have been reported on the ease or rapidity of nut digestion.

Nutritive Value.—Nuts are a concentrated food. This is clearly shown by the following figures:

1 pound of Almonds yield	2,895 calories
1 " " Brazil nuts yield	3,120 "
1 " " Filberts yield	3,100 "
1 " " Hickory nuts yield	3,345 "
1 " " Peanuts yield	2,610 "
1 " " Walnuts yield	3,075 "

The high fuel value is due to the absence of water and the large amount of fat present. Nuts can be most advantageously used along with bulky foods, such as fruits and vegetables, and those lacking in fat, such as bread. In a vegetarian diet they become a valuable source of protein.

Chestnut Purée (Wegele).—

Chestnuts	1 pound	553 gm.	1,125 calories
Butter	3 ounces	90 "	675 "
Salt	a little	1 "	
Sugar	a little	10 "	41 "

The chestnuts are peeled and boiled in water until the second (inside) skin comes off easily. They are then placed in a sieve until all the water

drains off, washed, and afterward pressed through a sieve. Melt the butter in a stewpan on the fire, add the salt and sugar—enough to cover the point of a knife—and then the chestnuts. Stew them for half an hour, stirring frequently; pour in enough bouillon so that the mush does not get too thick.

JELLIES

Gelatinous articles of nutrition are made from cartilage, tendons, connective tissue and bone. The gelatin is rapidly and completely decomposed in the alimentary canal and quickly reaches the tissues and serves as a preserver of protein and fats. Gelatinous food aids the coagulability of the blood and when taken in excess may cause diarrhea.

Chicken Jelly (Adams).—Clean a fowl that is about a year old, remove skin and fat, chop bones and flesh fine, place in a pan with two quarts of water; heat slowly; skim thoroughly; simmer five or six hours; add salt, mace or parsley to taste; strain, and cool. When cool, skim off the fat. The jelly is usually relished cold, but may be heated. Data for estimating the caloric value of this preparation are not available.

Veal-bone Jelly.—

Veal bones	10 pounds	5,000 gm.	1,615 calories
Water	10 quarts	10,000 c.c.	
Barley	2 pounds	1,000 gm.	3,300 "
Salt	a little	3 "	
Eggs	yolks	72 "	272 "

Place the veal bones and water or weak bouillon over the fire and just bring to a boil. Skim and add the barley and a little salt. Simmer for five or six hours and then strain. If too thick, dilute, before serving, with bouillon. Stir in the yolk of an egg for each cup and serve. Each cup will represent in full value about 100 calories.

Meat Jelly (Hepp).—This is made by cooking good boneless, lean beef on a water bath with a little water for sixteen hours or until it becomes gelatinized. Of the artificial preparations on the market for making bouillon, the most reliable is Liebig's Extract of Meat (10:250 grams), or Cibil's Bouillon (1 teaspoonful to 250 grams). Inaglio's bouillon capsules are also very convenient. If it is desired to make the bouillon more nutritious, one teaspoonful of meat peptone may be added.

Jelly for Dyspeptics (Weil).—

Calf's foot	1 pound	553 gm.	250 calories
Beef, or	¼ kilo	275 "	800 "
Hen (old)	½ fowl	1,000 "	1,800 "
Water	¼ liter	250 c.c.	
Salt	1 hp. teaspoonful	5 gm.	
Egg	1 (whole)	50 "	80 "
Cornstarch	a little	30 "	100 "
Extract of meat	1 tablespoonful	5 "	20 "

Remove the skin and meat from the calf's foot; wash the bones and place in cold water on the stove; when it begins to foam, skim off the refuse which gathers on top. After rinsing off the scum with cold water, put the bones into a pot with the beef or hen, water and salt, and boil slowly for from four to five hours. Pour the jelly thus formed through a fine sieve, and place overnight in a cellar. Next morning remove the fat, and clarify the cold jelly by adding the beaten egg with its shell mashed, and stirring steadily. Then, with the addition of a little cornstarch, subject the whole to a temperature not over 168° F., or the white of the egg will curdle. Constantly beat and stir. If the jelly begins to get grainy, cover and let it cool until the white of the egg becomes flaky and separates. Then strain again several times until it becomes perfectly clear; add the extract of meat, pour the jelly into a mold, and let it cool again. The gravy from a roast may be utilized and is very palatable. It must be stirred in while the mass is still warm and liquid. This jelly is usually relished with cold fowl, but spoils easily in summer; it must, therefore, be kept on ice. One hundred grams contain about 20 calories.

Calf's Foot Jelly (Sweet) (Watson).—

Ox foot, or	1 pound	553 gm.	250 calories
Calf's feet	1 pound	553 "	250 "
Sugar	½ pound	276 "	930 "
Eggs	4 (whole)	200 "	320 "
Lemons	4 (whole)	520 "	205 "
Mace	1 blade	1 "	
Cinnamon stick	1 inch	1 "	
Cloves	4 seeds	1 "	
Sherry wine	2 glasses	60 c.c.	76 "
Water	2 quarts	2,000 "	

Two calf's feet are equal to one ox foot, and make the same quantity of jelly; they are prepared in the same way as the ox foot, but need not be boiled quite so long. Get the ox foot broken across several times; split it up between the toes; take out the piece of fat between the toes and all

the marrow from the bones. First blanch the foot by thoroughly washing, covering with cold water and bringing it to the boil. Now place it in a basin of cold water, and scrape well.

After again rinsing in cold water, put it on in a clean pot with two quarts of cold water, bring it to the boil, skimming it well, and boil very gently for about eight hours. If very gently simmered by the side of the fire, the stock does not reduce too much. Strain it into a basin, either through a towel or a sieve, and stand aside to get quite cold. There should be six breakfastcupfuls of stock. When quite cold, remove all the fat from the top; this must be done very carefully. Now put the stock into a clean saucepan, add the sugar, the flavorings broken into small pieces, the lemon rind very thinly pared off, the juice strained, two eggs and the whites of the other two eggs beaten up, and a little crushed eggshell. Put this on the fire and whisk briskly until it comes to boiling point. Allow it to boil very gently about seven minutes. Withdraw from the fire, cover it with the lid, and allow it to settle for five or ten minutes.

Have a flannel or felt jelly-bag hanging up. Pour a good deal of boiling water through the bag to warm and cleanse it. When the water has all run out, put a clean basin under the bag and pour the jelly twice through the bag, when the jelly should be clear and a brilliant color. This jelly is excellent without wine. If wine is used, it is best put into the saucepan just before the jelly is poured into the bag.

Milk Jelly (Wegele).—

Milk	2 liters (4 pints)	2,000 c.c.	1,360 calories
Sugar	1½ cups	250 gm.	1,000 "
White gelatin	1 ounce	30 "	100 "
Water	1½ cups	250 "	
Good white wine	3 wineglassfuls	400 "	229 "

Boil the milk for five to ten minutes with the sugar and let cool. Make a solution of the white gelatin, add water and the white wine. Stir all slowly. Add to above. Pour into a mold and let cool. One hundred grams (one-half cup) are equivalent to 250 calories.

General Directions for Dishes Made with Gelatin.—Gelatin should be soaked in cold water for about half an hour to soften it. It may then be easily dissolved by adding boiling water. If it is desired to soften gelatin quickly, it should be placed in cold water and gradually heated over boiling water until it dissolves. If a jelly is to be strained, a wet cloth should be used for the purpose. Jelly molds should be wet with cold water before being filled. When granulated gelatin is used, much smaller amounts are required than when the ordinary form is used.

Wine Jelly (Drexel Institute).—

Granulated gelatin	1 teaspoonful	4 gm.	25 calories
Cold water	2 tablespoonfuls	30 c.c	
Hot water	½ cupful	125 "	
Sugar	2 tablespoonfuls	40 gm.	160 "
Lemon juice	½ teaspoonful	5 c.c	
Wine	2 tablespoonfuls	30 "	50 "

Soak the gelatin in the cold and hot water. Add the sugar and lemon juice, and when cooling add the wine.

Lemon Jelly.—Lemon jelly is made in the same manner as wine jelly, just described, using a tablespoonful of lemon juice in place of the quantity directed.

Orange Jelly.—

Lemon juice	2 teaspoonfuls	15 c.c	
Orange juice	4 tablespoonfuls	60 "	40 calories
Sugar	3 "	60 gm.	240 "

The above is made in a similar manner as the previous recipe, using the lemon juice, orange juice and sugar, but a little less of the boiling water.

Wine Jelly (Sweet Wine Jelly from Gelatin) (Watson).—

French sheet gelatin	1¼ ounces	37 gm.	222 calories
Cold water	3 gills	360 c.c.	
Lemon juice	½ gill	60 "	
Sherry wine	½ "	60 "	65 "
Brandy	1 tablespoonful	15 "	40 "
Loaf sugar	3 ounces	90 gm.	360 "
Lemon	1 rind	2 "	
Cloves	2 or 3	1 "	
Cinnamon stick	1 inch	1 "	
Egg	1 white	32 "	18 "

Put all the ingredients into a lined saucepan; whisk until they boil; remove to the side of fire when the scum begins to rise in the top. Cover the top of the pan with a plate, and allow it to stand fifteen minutes. Strain through a hot jelly cloth three or four times till clear; when cold, mold in a scalded wet mold.

Cream Jelly or Blancmange (Watson).—

Milk	1 gill	60 c.c.	45 calories
Cream	1 "	60 "	120 "
Isinglass	¼ ounce	7 gm.	42 "
Lemon	1 rind	4 "	
Sugar	1 ounce	30 "	120 "

Rinse out a small saucepan and put into it the milk, isinglass and thinly peeled rind of half a lemon. Let this stand by the side of the fire until the isinglass is dissolved and the milk well flavored with the lemon. Stir occasionally to prevent boiling. Add the sugar, and strain into a basin to keep back the lemon rind. Add the cream, and stir occasionally until nearly cold. If not stirred, the milk and cream will separate. Pour into a small basin that has been rinsed out with cold water, and place in a cool position to set. Turn out and serve with a little red or black currant jelly.

Nutritious Coffee Jelly (Thomas).—

Isinglass or gelatin	a little	2 gm.	12 calories
Freshly ground coffee	½ ounce	15 "	
New milk	1 pint	500 c.c.	340 "
Egg	1 (whole)	50 gm.	80 "

Dissolve the isinglass or gelatin in water, put the coffee into a saucepan with the new milk, which should be nearly boiling before the coffee is added; boil together for three minutes; clear it by pouring some of it into a cup and dashing it back again; add the gelatin, and leave it to settle in a warm place for a few minutes. Beat up the egg in a breakfast cup, and pour the coffee upon it; if preferred, drink without the egg.

Milk Jelly (Schlesinger).—

Milk	2 quarts	2,000 c.c.	1,360 calories
Sugar	½ pound	275 gm.	930 "
Gelatin	1 ounce	30 "	108 "
Cold water	1 cupful	250 c.c.	
Juice of lemons	2 or 3	40 "	
Good Bordeaux wine	3 glasses	90 "	135 "

To the milk add the sugar. Boil for five or ten minutes. Cool and add the gelatin dissolved in the cold water. Flavor with the juice of the lemons and wine.

Irish-moss Blancmange (Drexel Institute).—

Irish moss	1 tablespoonful	8 gm.	30 calories
Milk	½ cupful	175 c.c.	85 "
Salt	a little	1 gm.	

Wash the moss in several changes of water, and pick it over carefully. Place it in a double boiler, together with the milk. Cook until it thickens when dropped on a cold plate. Add salt, strain and flavor. Pour into a custard cup that has first been rinsed in cold water.

Meat Jellies with Gelatin.—

Meat broth	1 pint	500 c.c.	52 calories
Granulated gelatin	1 teaspoonful	4 gm.	25 "

Use any kind of meat broth desired, but always one with appetizing flavor. Add the gelatin to enough broth to cover it, and allow the gelatin to soak for a few minutes. Then add the remainder of the broth very hot, and stir until the gelatin is dissolved. Strain and pour into molds to cool.

Meat Jellies with Tapioca.—

Broth	1 cupful	250 c.c.	26 calories
Powdered tapioca	4 level tablespoonfuls	60 gm.	90 "
Salt	a pinch	1 "	

Mix the broth as above with the powdered tapioca. Heat until quite clear, stirring constantly. Add salt and season as desired. Pour into molds and cool.

Meat Jellies with Irish Moss.—

Irish moss	2 tablespoonfuls	8 gm.	25 calories
Hot broth	1 cupful	250 c.c.	26 "

Wash the moss thoroughly. Add this to the hot broth and allow it to stand for half an hour; then heat slowly, stirring constantly, and boil for ten minutes, preferably in a double boiler. Strain, pour into molds, and cool.

CUSTARDS

Rules for Custards (Drexel Institute).—The eggs should be thoroughly mixed but not beaten light, the sugar and salt added to these, and the hot milk added slowly. Custards must be cooked over moderate heat; if a custard curdles, put it in a pan of cold water and beat until smooth. Custards should always be strained.

Soft Custard.—

Milk	1 pint	500 c.c.	345 calories
Eggs	2 yolks	36 gm.	130 "
Sugar	2 tablespoonfuls	30 "	120 "
Salt	a pinch	1 "	
Vanilla	2 teaspoonfuls	4 c.c.	
Sherry	4 "	30 "	38 "

Mix the yolks of eggs, sugar and salt in a bowl. Heat the milk to the boiling point and add to the eggs, sugar and salt, stirring constantly. As soon as mixed, pour into the saucepan in which the milk has been heated,

and cook from three to five minutes, stirring constantly until it thickens. Strain, and pour into a cold bowl, and flavor with vanilla, sherry or other flavoring material as desired. Custards may be cooked to advantage in a double boiler.

Savory Custard (Anderson).—Add the yolks of two eggs to a cupful of beef tea, with pepper and salt to taste. Butter a cup or a jam pot; pour the mixture into it, and let it stand in a pan of boiling water till the custard is set.

This will furnish 150 calories.

Custard Sauce (Watson).—

Eggs	2 yolks	36 gm.	135 calories
Egg	1 white	32 "	18 "
Sugar	1 dessertspoonful	8 "	32 "
Milk	½ pint	250 c.c.	170 "
Flavoring	a few drops	1 "	

Rinse out a small lined saucepan with cold water, put the milk into it, and let it heat over the fire. Put the yolks and white of egg into a basin with sugar, and mix them well together with a wooden spoon. Then pour the hot milk gradually onto them, stirring all the time and mixing thoroughly. Return all to the saucepan, and stir very carefully over the fire until the sauce thickens. On no account must it be allowed to boil, or it will curdle. Have ready at hand a clean basin and strainer. As soon as the sauce shows signs of thickening, and it is almost boiling, remove the pan from the fire, continue stirring for a few moments, and then strain into a basin. Add flavoring to taste—lemon, vanilla, nutmeg or cinnamon. This can be made richer by increasing the proportion of yolks to white. It can be served as sauce, or in a custard glass, with flavoring grated on the top.

Baked or Cup Custard (*Individual Rule*) (Pattee).—

Milk	1 cup	250 c.c.	170 calories
Egg	1 (whole)	50 gm.	80 "
Sugar	1½ tablespoons	6 "	24 "
Salt	½ saltspoon	1 "	
Flavoring to taste: nutmeg, cinnamon, vanilla, or lemon extract.			

Scald the milk; beat the egg, add sugar and salt, and pour onto it gradually the scalded milk. Flavor to taste and pour into custard cups; place in deep pan and pour boiling water around until it almost reaches

the top of cups. Bake in moderate oven about twenty minutes. If cinnamon is used for flavor, put one-half square inch into the milk when scalding.

Note.—To test, dip a pointed knife into water and plunge into the middle of the custard. If it looks set and the knife comes out clear, the custard is done; if milky, it is not cooked enough. If cooked too long the custard will curdle.

Chocolate Custard (*Individual Rule*) (Fitch).—

Walter Baker's chocolate	2 teaspoonfuls	15 gm.	89 calories
Milk	2 tablespoonfuls	30 c.c.	42 "
Rich milk	6 "	90 "	160 "
Eggs	2 yolks	36 gm.	130 "
Sugar	2 teaspoonfuls	8 "	32 "
Salt	a speck	1 "	

Grate chocolate and mix with the two tablespoons of milk; stir over the fire until smooth, add the rich milk, the well-beaten egg yolks, sugar and salt. Pour into custard cups set in pan of hot water (nearly to the top). Cook until custard is set. Serve hot or cold.

Custard Soufflé (*Individual Rule*) (Pattee).—

Butter	1 tablespoonful	15 gm.	120 calories
Flour	1¼ tablespoons	37 "	118 "
Scalded milk	¼ cup	60 c.c.	40 "
Egg	1 yolk	18 gm.	65 "
Sugar	1¼ tablespoons	20 "	80 "
Egg	1 white	32 "	18 "

Melt butter, add flour, and then gradually the scalding milk. Cook thoroughly, pour into the well-beaten yolk, add sugar, and cool. Fold into mixture the well-beaten whites. Turn into buttered custard cups and bake about fifteen minutes, until firm—determined by pressing with the finger. Take from oven and serve at once, or it will fall. Serve with foamy sauce.

Peach Meringue (*Individual Rule*) (Pattee).—

Yellow peaches	1 cup	253 gm.	58 calories
Sugar to taste	2 tablespoonfuls	30 "	120 "
Egg	1 yolk	18 "	65 "
Bread crumbs	1 tablespoonful	15 "	15 "
Egg	1 white	32 "	18 "
Powdered sugar	1 tablespoon	16 "	64 "

Stew peaches in a very little water, sweeten to taste, and stir in the well-beaten yolk. Butter a pudding dish and cover bottom with fine bread crumbs; put in the peaches and bake fifteen minutes. Cover with

meringue made of white of egg and the powdered sugar; brown slightly in the oven. Serve cold.

Cocoa Junket.—

Cocoa	1 teaspoonful	4 gm.	50 calories
Milk sugar	1 ounce	30 "	120 "
Milk	5 ounces	150 c.c.	100 "
Junket tablet	¼	0.25 gm.	
Cold water	1 ounce	30 c.c.	

Dissolve the junket tablet in the water. Mix the cocoa and sugar, add the milk, and heat lukewarm, stirring constantly; add the dissolved junket tablet, stir thoroughly, and leave in a warm place to set.

Soft Custard.—

Milk	1 cup (8 ounces)	250 c.c.	160 calories
Egg	1 (whole)	50 "	80 "
Milk sugar	2 ounces	60 gm.	240 "
Salt	a speck.		
Vanilla	2 to 3 drops.		
Caramel, made of granulated sugar	3 tablespoonfuls	45 "	180 "

Beat the egg slightly; add the sugar, salt and hot milk slowly. Cook in a double boiler, stirring constantly, until it thickens a little (if cooked too long the custard will curdle, but may become smooth again if set in a dish of cold water and beaten at once). Flavor and cool.

To make caramel: Put the sugar in a pan directly over heat and burn until a very dark brown. Dissolve in hot water or milk.

Plain Junket or Rennet Custard.—

Milk sugar	1 ounce	30 gm.	120 calories
Milk	5 ounces	150 c.c.	100 "
Junket tablet	¼	0.25 gm.	
Cold water	1 ounce	30 c.c.	
Vanilla	few drops.		

See directions for Cocoa Junket.

Baked Custard.—

Milk sugar	1⅓ ounces	40 gm.	160 calories
Milk	6 ounces	180 c.c.	120 "
Egg	1 (whole)	50 gm.	80 "
Nutmeg or vanilla.			
Salt	a speck.		

Beat the egg slightly; warm the sugar and milk, stirring constantly; add to the egg, strain into a custard cup, and flavor. Bake in a pan of

water in a moderate oven until a knife, when cut into it, will come out clean (one-half to one hour).

PUDDINGS

Bread Pudding.—

Milk sugar	$1\frac{1}{2}$ ounces	45 gm.	180 calories
Milk	6 ounces	180 c.c.	120 "
Egg	1 (whole)	50 gm.	80 "
Bread	1 slice $\frac{3}{8}''$ thick	20 "	60 "
Butter	$\frac{1}{2}$ ounce	15 "	120 "

Spread the bread with butter, and cut into squares. Beat the egg slightly; heat the milk and sugar, stirring constantly; mix with the egg and pour over the bread. Grate nutmeg over the top, and bake the same as custard.

Rice Pudding.—

Rice	3 tablespoonfuls	100 gm.	360 calories
Milk	1 quart	500 c.c.	700 "
Salt	a pinch	1 gm.	
Sugar	1 cup	280 "	1,148 "
Butter	1 hp. teaspoonful	15 "	120 "

Cinnamon, nutmeg, or vanilla to taste.

Wash the rice with water. Add to the milk and cook slowly on top of the stove for one hour, or a little longer, until the mixture becomes creamy. Add the sugar, butter and cinnamon. Put into a dish to set, and bake in an oven until the top is browned. The whole pudding furnishes five to six portions.

Rice and Egg Pudding (Caultey).—

Rice	3 ounces	90 gm.	315 calories
Milk	1 pint	500 c.c.	350 "
Butter	1 ounce	30 gm.	240 "
Powdered sugar	2 ounces	60 "	240 "
Eggs	3 yolks	54 "	180 "
Lemon peel	1 grated	2 "	
Eggs	3 whites	96 "	54 "
Powdered sugar	3 tablespoonfuls	45 "	185 "

Take the rice and swell it gently in the new milk. Let it cool, and stir well into it the fresh butter, powdered sugar, the yolks of the eggs, and some grated lemon peel. Pour into a well-buttered dish and put on the top the whites of the eggs beaten with the powdered sugar. Bake for twenty minutes until lightly browned. The whole pudding furnishes six portions.

Arrowroot (Pavy).—Mix thoroughly two teaspoonfuls of arrowroot with three tablespoonfuls of cold water, and pour on them half a pint

of boiling water, stirring well meanwhile. If the water is boiling, the arrowroot thickens as it is poured on, and nothing more is necessary. If only warm water is used, the arrowroot must be afterward boiled until it thickens. Sweeten with loaf sugar, and flavor with lemon peel or nutmeg, or add sherry, port wine or brandy, if required. Boiling milk may be employed instead of water, but when this is done no wine must be added, as the milk would curdle.

Cornstarch Pudding (*Individual Rule*) (Pattee).—

Milk	1 cupful	250 c.c.	170 calories
Cornstarch	1½ tablespoons	28 gm.	90 "
Sugar	1½ "	28 "	112 "
Salt	a speck	1 "	
Egg	1 white	32 "	18 "
Vanilla extract	a few drops.		

Scald the milk in a double boiler. Mix cornstarch, sugar and salt thoroughly; add slowly the scalded milk, stirring constantly. Return to top of boiler and cook twenty minutes, stirring constantly for the first five or six minutes, then occasionally. Remove from fire, and while very hot, fold in lightly, but thoroughly, the well-beaten white of egg. When partially cooled add flavoring to taste; put into wet cups or molds, cool, and then stand for several hours on ice. Remove from molds. Serve with a soft custard, mashed fresh berries, or whipped cream. Vary the pudding by adding a little Walter Baker's chocolate, melted.

Pineapple Cream (*Individual Rule*) (Pattee).—

Milk	1 cupful	250 c.c.	170 calories
Cornstarch	1½ tablespoons	28 gm.	90 "
Sugar	1½ "	28 "	112 "
Salt	a speck	1 "	
Egg	1 white	32 "	18 "
Grated pineapple	2 tablespoons	50 "	22 "

Follow directions for Cornstarch Pudding, adding the pineapple instead of vanilla. Pour into individual molds and serve cold with cream.

Plain Rice Pudding (*Individual Rule*).—

Steamed rice	1 cupful	300 gm.	300 calories
Scalded milk	1 "	250 c.c.	170 "
Butter	1 tablespoonful	15 gm.	120 "
Egg	1 (whole)	50 "	80 "
Sugar	2 tablespoonfuls	30 "	120 "
Salt	½ saltspoon	1 "	
Raisins (stoned)	¼ cup	100 "	320 "

Scald milk and add butter. Beat egg, add sugar and salt, and pour on slowly the scalding milk. Put in pudding dish with rice and raisins. Put bits of butter on top, and bake in a moderate oven until custard is set. Serve with hard sauce. Do not use raisins in cases of bowel trouble.

Chocolate or Cocoa Blancmange (Pattee).—

Minute tapioca	¼ cupful	30 gm.	45 calories
Sugar	¼ "	30 "	120 "
Salt	¼ teaspoonful	1 "	
Hot chocolate or cocoa	1½ cups	340 "	418 "
Vanilla	¼ teaspoonful.		

The above quantity is sufficient for three servings containing 195 calories each.

Mix tapioca, sugar and salt; pour on gradually the hot cocoa, and cook in double boiler about twenty minutes. Remove from heat, add vanilla, and pour into cold, wet molds. Serve cold, plain or with whipped cream or soft custard.

Plain Bread Pudding (Pattee).—

Stale bread	1 cupful	120 gm.	120 calories
Milk	1 "	250 c.c.	170 "
Butter	1 tablespoonful	15 gm.	120 "
Egg	1 (whole)	50 "	80 "
Sugar to taste	2 tablespoonfuls	30 "	120 "
Salt	½ saltspoon	1 "	
Seeded raisins	¼ cup	100 "	320 "

Scald milk and add butter. Beat the egg and add sugar and salt; pour on gradually the scalding milk. Cut the bread into one-half inch cubes and add with the raisins. Pour into well-buttered pudding dish, put bits of butter on top, and bake in a moderate oven until the custard is set. Serve with hard sauce or cream and sugar. Do not use raisins in bowel trouble. The above quantity is sufficient for two servings and contains 930 calories.

Tapioca and Sago Pudding (Watson).—

Tapioca or sago	¾ ounce	30 gm.	48 calories
Cold milk	½ pint	250 c.c.	170 "
Egg	1 (whole)	50 gm.	80 "
Sugar	1 teaspoonful	5 "	20 "
Flavoring	to taste.		

If small crushed tapioca or sago is used, the directions are the same as for semolina pudding. If not, the recipe is as follows:

Cover the grain with milk, and soak for an hour. Rinse out a small lined saucepan, turn the tapioca and milk into it, and stir over the fire until it comes to the boil. Then simmer slowly until it turns clear, stirring every now and then. This takes from twenty to thirty minutes. If it becomes too thick while cooking, add a little more milk. Then finish off the pudding with eggs, etc., as in semolina.

Baked Bread and Butter Pudding (Watson).—

Thin bread and butter	2 slices (⅜″ thick)	40 gm.	120 calories
Sugar	1 teaspoonful	5 "	20 "
Milk	½ pint	250 c.c.	170 "
Egg	1 (whole)	50 gm.	80 "
Grated nutmeg	to suit.		

Cut some bread and butter rather thin, remove the crusts, and cut into pieces about an inch square. Lay these into a small greased pie-dish, making the dish just about half full; beat up the egg in a small basin, and add the nutmeg, sugar and milk. Mix well together and pour over the bread in the pie-dish. Allow the pudding to stand about ten minutes until the bread gets thoroughly saturated, then bake in a moderate oven from ten to fifteen minutes until nicely browned on the top. Sprinkle with sugar.

Sponge Pudding (Wegele).—

Butter	¾ ounce	20 gm.	170 calories
Flour	1¾ ounces	50 "	180 "
Milk	½ pint (¼ pound)	250 c.c.	170 "
Egg	1 yolk	18 gm.	65 "
Butter	¾ ounce	20 "	160 "
Eggs	2 yolks	36 "	130 "
Sugar	1 tablespoonful	15 "	60 "
Vanilla	a little.		
Eggs	3 whites	96 "	54 "

Melt the butter in a saucepan. Thoroughly mix the flour and milk, boil in the saucepan containing the melted butter. Let the mixture cool off, and then add the yolk of the one egg. Beat to a cream the butter and yolks of two eggs, add sugar and vanilla, and add to above. Beat stiff the whites of three eggs and add. Butter a pudding dish, dust same with bread crumbs, put the entire batter into the pudding dish and allow to steam for one hour. One hundred grams (3¼ oz.) are equivalent to about 220 calories.

A vanilla or wine sauce may be served with this pudding. The pudding can be baked, if so desired.

ICE CREAM

Chocolate Ice Cream (Pattee).—

Thin cream	½ cup	80 gm.	216 calories
Walter Baker's chocolate	1 ounce	30 "	180 "
Sugar	1½ tablespoonfuls	15 "	60 "
Boiling water	1 tablespoonful	15 c.c.	
Vanilla	¼ teaspoonful	1 "	
Salt	a speck	0.5 gm.	

Melt the chocolate over hot water, add the boiling water, sugar and hot cream. Cool, add vanilla and salt, and freeze in small pail.

Junket Ice Cream (Pattee).—

Cream	½ cup	80 gm.	216 calories
Milk	½ "	125 c.c.	85 "
Sugar	2½ tablespoons	25 gm.	100 "
Hansen's junket tablet	⅛ tablet		
Cold water	2 teaspoonfuls	15 c.c.	
Vanilla	⅔ "	25 "	

Heat the milk until lukewarm, add the sugar and vanilla; when sugar is dissolved, add the tablet dissolved in the cold water. Allow it to stand in warm room until firm, then beat thoroughly and turn into small pail and freeze. The above quantity is sufficient for two servings.

A variety may be made by adding two teaspoons cocoa dissolved in a little boiling water. Add to mixture before adding the tablet. Serve the cream plain or with whole strawberries, etc. The junket improves the body or consistency of any cream.

Strawberry Ice Cream (Pattee).—

Thin cream or rich whole milk	½ cup	80 gm.	216 calories
Milk	½ "	125 c.c.	85 "
Strawberries	¼ "	200 gm.	60 "
Sugar	2 tablespoons	20 "	80 "
Salt	a speck	1 "	

Mash the strawberries with the sugar, and allow them to stand five minutes. Add the cream and milk and freeze in small pail. The berries may be mashed and strained through cheesecloth.

Peach Ice Cream (Pattee).—

Thin cream or rich whole milk	½ cup	80 gm.	216 calories
Milk	½ "	125 c.c.	85 "
Peaches	¼ "	256 gm.	85 "
Sugar	2 tablespoons	20 "	80 "

Mix peaches and sugar and press through a potato ricer or sieve. Scald cream and milk. Cool, and add peaches and sugar. Freeze in small pail.

Caramel Ice Cream (*Individual Rule*) (Pattee).—

Thin cream or rich whole milk	½ cupful	80 gm.	216 calories
Milk	½ "	125 c.c.	85 "
Sugar	2 tablespoonfuls	30 "	80 "
Boiling water	2 "	30 "	
Vanilla	⅛ teaspoon	20 "	
Salt	a speck	1 gm.	

Into saucepan place the sugar and stir constantly until melted. Add water and boil until reduced to one and one-half tablespoons. Add cream very slowly, vanilla, salt, and freeze.

Vanilla Ice Cream.—

Cream	4 ounces	120 c.c.	240 calories
Milk	2 "	60 "	40 "
Milk-sugar	2 "	60 gm.	240 "
Vanilla	a few drops	1 c.c.	

Mix the cream, milk and sugar, and heat, stirring constantly, until the sugar is dissolved. Then flavor, cool and freeze.

RECIPES FOR DIABETIC FOODS

Gum Gluten Bread.—

Gum gluten flour	4 cups	553 gm.	1,160 calories
Scalded milk	1 cup	250 c.c.	170 "
Cold water	1 "	250 "	
Butter	1 tablespoonful	15 gm.	120 "
Fleischmann's Yeast	½ cake	2 "	
Salt	½ teaspoonful	2 "	

Put the hot water or milk in the mixing bowl. Add the butter, and when melted, add the salt and cold water. Dissolve the yeast in a little lukewarm water, and add to the above mixture, being careful that the liquid is not too warm. Stir in the flour, and knead thoroughly in the bowl. Set to rise in a warm place, having the bowl well covered and away from draughts. When doubled in bulk, cut down, and knead again in the bowl. Cover and let rise the second time. When light, cut it down, turn onto a well-floured board, knead into shape, and place in a greased bread pan. Cover and let rise to top of pan. Bake in a moderate oven one hour and a half. Turn out on a wire sieve to cool.

Gum Gluten Muffins.—

Gum gluten flour	1 cup	140 gm.	290 calories
Egg	1 (whole)	50 "	80 "
Milk	1 cup	250 c.c.	170 "
Butter, melted	1 tablespoonful	15 gm.	120 "
Baking powder	2 teaspoonfuls	8 "	
Salt	¼ teaspoonful	1 "	

Sift flour, salt and baking powder together. Beat the egg, to which add the milk, and beat in the flour gradually, using Dover egg beater. Now add the melted butter, and when the mixture is smooth and light, drop in smoking hot, greased iron gem pans, and bake forty-five minutes in a moderate oven.

Aleuronat Bread (Ebstein).—

Ordinary wheat flour	6 ounces	180 gm.	600 calories
Aleuronat powder	6 "	180 "	576 "
Butter (best)	5 "	150 "	1,220 "
Salt	1 teaspoonful	1 "	
Baking powder	¾ of ounce	22 "	
Milk	2 ounces	60 "	85 "

Mix the flour and the aleuronat in a warm dish, and add gradually the melted butter and milk (made lukewarm), followed by the salt, and finally by the baking powder (one part of sodium carbonate and two parts of cream of tartar). The dough is well mixed, then molded into two loaves, and baked at a good heat.

Bran Bread.—

Bran	½ pound	280 gm.	
Almond flour	2 ounces	60 "	375 calories
Butter	3 "	90 "	720 "
Eggs	6 (whole)	300 "	480 "
Milk	½ pint	250 c.c.	170 "
Bicarbonate of soda	2 teaspoonfuls	8 "	
Tartaric acid	1 teaspoonful	4 "	

Place the butter in a basin and beat it to a cream, then add the almonds and beat well; add the eggs one at a time. Partly mix in the bran before adding the milk. Mix the whole together, place it in a well-buttered tin, and bake for an hour in moderate oven.

Camplin's Bran Cakes.—

Wheat bran	1 quart	543 gm.	
Eggs	3 (new laid)	150 "	240 calories
Butter	2 ounces	60 "	480 "
Milk	½ pint	250 c.c.	170 "
Soda-bicarbonate	1 teaspoonful	4 gm.	

Take a sufficient quantity of wheat bran, boil it in two successive waters for a quarter of an hour, each time straining it through a sieve; then wash it well with cold water (in the sieve) until the water runs off perfectly clear; squeeze the bran through a cloth as dry as possible, and spread it thinly on a dish; place it in a slow oven; if put in at night, let it remain until the morning, when, if perfectly dry and crisp, it will be ready for grinding. The bran thus prepared must be ground in a mill and sifted through a wire sieve that has so fine a mesh that a brush must be used to pass it through; that which remains in the sieve must be reground until it becomes quite soft and fine. Take of this bran powder three ounces (some persons use four ounces). Mix the eggs with a little of the milk, and warm the butter with the remainder; add the bran, and stir the whole well together, adding the soda and a little nutmeg or ginger or any other agreeable spice. Bake in small tins (patty pans), which must be well buttered, in a somewhat quick oven for about half an hour. When baked, the cakes should be a little thicker than a captain's biscuit; they may be eaten with meat or cheese for breakfast, dinner or supper. At tea they require a somewhat liberal allowance of butter, or they may be eaten with curd or with any soft cheese. It is important that the flour be prepared as directed above. If the cakes do not keep well or if they have not been well prepared, place them before the fire for ten minutes every day.

Waffles.—

French gluten flour	1 cup	140 gm.	290 calories
Eggs	2 (whole)	100 "	160 "
Milk	1 cupful	250 c.c.	170 "
Butter	1 tablespoonful	15 gm.	120 "
Baking powder	1½ teaspoonfuls	6 "	
Salt	¼ teaspoonful	1 "	

Sift flour, salt and baking powder together. Rub in the butter. Beat the eggs, to which add the milk, and stir in the flour gradually. Beat well, and bake on a hot, well-greased waffle iron. Serve hot, with butter or cream.

Almond Cakes No. 1 (Saundby).—

Almonds (ground)	1 pound	553 gm.	3,030 calories
Eggs	4 (whole)	200 "	320 "
Milk	2 tablespoonfuls	30 c.c.	40 "
Salt	a pinch	1 gm.	

Beat up the eggs, add the milk, stir in the almond flour and salt; place in twelve flat tins and bake in a moderate oven for about fifteen minutes.

Almond Cakes No. 2 (Seegen).—

Sweet almonds	¼ pound	250 gm.	757 calories
Butter	3 ounces	90 "	720 "
Eggs	2 (whole)	100 "	160 "
Eggs	3 yolks	54 "	195 "
Salt	a little	1 "	
Eggs	3 whites	92 "	54 "

Break up the almonds in a stone mortar (or almond flour may be used). Put the flour thus prepared into a linen bag, which should then be immersed for one-quarter of an hour in boiling water, acidulated with a little vinegar, to remove the small amount of sugar from the almonds. Mix well with the butter and two eggs. Then add the three yolks of eggs and the salt, and stir the whole briskly for some time. Beat the whites of eggs to a fine froth and add to the mixture. The paste is then made into biscuits, smeared with butter, and baked with a gentle fire.

Cocoanut Cakes.—

Desiccated cocoanut powder	1 pound	553 gm.	3,000 calories
Yeast	1 cake	30 "	
Warm water	2 ounces	60 c.c.	
Eggs	2 (whole)	100 gm.	160 "
Milk	2 ounces	60 c.c.	80 "
Salt	1 saltspoonful	1 gm.	

Mix water and yeast into a paste; add to cocoanut powder, if necessary using more water. After thoroughly mixing, leave in a warm place for thirty minutes. Beat up the eggs and milk, add salt, then put into mixing bowl with the cocoanut powder and yeast; heat again and mix thoroughly. Then place into a well-greased gem pan containing sixteen compartments. Bake in a moderately hot oven for twenty minutes. Almond cakes may be made in the same way.

Aleuronat and Almond Cakes (Williamson).—

Aleuronat	3 ounces	90 gm.	288 calories
Almond flour	3 "	90 "	561 "
Egg	1 (whole)	50 "	80 "
Cream	2 teaspoonfuls	30 c.c.	108 "
Water	a little	30 "	

Moisten the aleuronat with a little water containing saccharin and let it stand for a few minutes; then add the almond flour, the egg, the cream, and the water just as required to make a light paste. Spread on a tin. Cut into squares, and bake in a moderate oven for twenty minutes.

Almond Biscuit (Mrs. Hart).—

Almond flour	1 pound	553 gm.	3,030 calories
Eggs	2 whites	64 "	36 "
Salt to taste	¼ teaspoonful	1 "	

To the flour add the whites of the eggs and salt. Whip the whites to a stiff froth, add the almond flour, and beat well together. Put in buttered patty pans and bake in a moderately quick oven for from fifteen to twenty minutes. The whole must be done quickly, and baked as soon as the ingredients are mixed. This biscuit is a useful substitute for bread.

Aleuronat Pancakes (Williamson).—

Egg	1 (whole)	50 gm.	80 calories
Water and cream	a little	30 c.c.	54 "
Aleuronat powder	2 teaspoonfuls	30 gm.	187 "
Baking powder	½ teaspoonful	2 "	
Salt	a little	1 "	

Beat up the egg in the water and cream; mix the aleuronat powder, baking powder and salt, and then add gradually to the egg and cream and beat into a batter; allow it to stand for five minutes. If it is too thick, add a little more cream and water. Fry in an ordinary frying-pan greased with a little lard. At the end of about eight minutes, when the under surface is browned, turn it over and continue to bake for five minutes longer.

Aleuronat and Suet Pudding (Williamson).—

Aleuronat flour	2 ounces	60 gm.	374 calories
Suet	2 "	60 "	540 "
Egg	1 (whole)	50 "	80 "
Salt	a pinch	1 "	
Baking powder	½ teaspoonful	2 "	

This is a palatable and cheap dish. Sprinkle a little aleuronat flour on a chopping-board and chop the suet on this part of the board. Then mix the remaining aleuronat with the suet in a pan. Add the salt and the baking powder. Beat up the egg in about three tablespoonfuls of water to which a little saccharin has been added. Add the egg gradually to the suet mixture, rubbing the whole mass well into a paste. It may be necessary to add a little more water. Drop into a tin pudding mold smeared with butter or lard, float it in a pan of water, and boil for two hours, taking care that the boiling water does not get into the mold; or, better still, the pudding may be baked in the oven. Its taste is improved by the addi-

tion of half an ounce of almonds. A small quantity of red wine may serve as a sauce.

Cocoanut Pancakes (Williamson).—

Egg	1 (whole)	50 gm.	80 calories
Milk	2 tablespoonfuls	30 c.c.	25 "
Salt	a pinch	1 gm.	
Cocoanut powder	2 tablespoonfuls	30 "	187 "

Beat up the egg in the milk, or, better, in a little cream and water, and add the salt. Then add the cocoanut powder (freed from sugar). Allow this to stand from five to ten minutes. Add a little more cream and water. Mix well until it is a little thicker than ordinary pancake batter. Put a little lard in the frying-pan and heat until the lard is just melted; then drop in half of the mixture. Allow this to remain over a moderate fire for a few minutes—about five—until the under surface is brown; then turn the cake over and heat for another five minutes. The other half of the mixture may be used for the second pancake.

Cocoanut Cakes (Williamson).—

Cocoanut powder	3 tablespoonfuls	45 gm.	250 calories
German yeast	a little	1 "	
Water	q. s.		
Solution of saccharin	small quantity	0.5 "	
Egg	1 (whole)	50 "	80 "
Cream	2 teaspoonfuls	30 c.c.	60 "

Mix the cocoanut powder into a paste with the yeast and water. The mixture should be allowed to remain by the fire or in a warm place for about twenty minutes, or until fermentation occurs and it becomes "puffy." Then add the watery solution of saccharin. Beat up the egg, and add this with the cream and a little water to the cocoanut paste. The whole should be well mixed, dropped into small tins, and baked in an oven for about thirty minutes.

Cocoanut and Almond Cakes (Saundby).—

Cocoanut powder (finest)	¾ pound	277 gm.	2,250 calories
Ground almonds	¼ "	138 "	760 "
Eggs	6 (whole)	300 "	480 "
Milk	½ cupful	125 c.c.	85 "

Beat up the eggs and stir in the cocoanut and almond flour. Divide into sixteen flat tins, and bake for twenty-five minutes in a moderate oven.

Cocoanut Pudding (Williamson).—

Cocoanut powder	3 tablespoonfuls	45 gm.	275 calories
Water	a little	30 c.c.	
German yeast	a little	1 gm.	
Cream	4 tablespoonfuls	60 c.c.	120 "
Egg	1 (whole)	50 gm.	80 "
Salt	a little	1 "	
Water sweetened with saccharin	½ pint		

Mix the cocoanut powder with a little water and German yeast, and keep for twenty minutes in a warm place, so as to allow the small quantity of sugar present to decompose; add the cream, egg, a little salt, and water sweetened with saccharin. Mix into a paste. Place in a dish greased with butter. Cook like rice pudding, in a slow oven for thirty minutes.

Almond Pudding (Mrs. Hart).—

Eggs	2 (whole)	100 gm.	160 calories
Almond flour	¼ pound	138 "	760 "
Butter	¼ "	140 "	900 "
Saccharin	3 tabloids	1 "	
Brandy	1 tablespoonful	15 "	100 "

Warm the butter, beat in the almond flour and the yolks of the eggs, and add the saccharin dissolved in the brandy. Whip the whites into a stiff froth, and beat all together. Put into dariole molds and bake in a quick oven. Serve with a little hot sauce made with dry sherry and saccharin.

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CHAPTER XVIII

ARMY AND NAVY RATIONS

GEORGE N. KREIDER, A.M., M.D., F.A.C.S.

U. S. Army Rations: Garrison Ration; Field Ration; Haversack Ration; Travel Ration; Filipino Ration; Emergency Ration; Savings; Concentrated Food; Company Dietaries; Tropical Dietaries; Army Rations Past and Present.
Rations for Boys' Military Training Camps: Menu, Boys' Military Training Camp, Fort Terry, N. Y.; Properly Balanced Dietaries for Boys' Military Training Camps.
Rations of Foreign Armies: Germany; Russia; Japan; France; Great Britain; Systems of Supply; Comparative Rations of the Armies of the World.
Diet in Prison Camps.
Conclusions Regarding the Composition and Food Value of the Military Ration.
Navy Rations.

U. S. ARMY RATIONS

The best ration for a soldier is a subject which has held the attention of army officers for many decades. An army is a collection of active, disciplined, healthy men in the prime of life, to be used as a fighting force in the service of the nation, and it is the prime object of military administration so to govern and train such men that they shall be fit when fighters are needed.

Unless a man is maintained in a good physical condition, he is useless for military purposes. For this reason the utmost care and attention should be given by commanding officers to every detail which pertains to the health of the soldier. Improper clothing, food, shelter and exercise are all sure to result in a loss of efficiency, but it is without question that insufficient food, improper food, or food improperly prepared will lead to damage or disaster more quickly than any other cause. A well-balanced ration, therefore, is the first and foremost question to be considered if the individual soldier's efficiency is to be maintained.

The quantity of each kind of foodstuff the soldier shall have usually rests, when the law allows a choice, with the department commander. It

has been the usual custom to order a ten days' ration in which there are seven issues of beef, two of bacon, and one of pork. If the soldier can, with the help of outside purchases, manage to subsist for ten days on the beef allowed for seven, he saves the money value of one day's pork ration and two of bacon, and these savings are usually turned into a company fund from which extra food can be purchased on holidays, when there is a convenient market, as, for instance, turkey on Thanksgiving and Christmas and eggs at Easter. This fund is considered of the highest importance, and new restrictions are constantly being thrown around it to prevent the savings from the ration being diverted to other purposes.

TEN DAYS' RATION UNCOOKED FOOD FOR AN AVERAGE DAILY OF 440.4 MEN (WOODRUFF(1))

	Gross Weight	Waste	Net Weight	Weights in Pounds		Fats	Carbohydrates	Salts	Calories
				Water	Protein				
Bacon	273¾	3¾	270	54.00	21.60	187.65	......	6.75	831,600
Beans	428½	......	428½	54.05	99.10	8.57	253.80	13.29	691,228
Pork	343¾	31	312¾	37.85	2.82	259.00	......	13.14	1,097,753
Sugar, brown	731	......	731	21.93	......	......	......	3.66	1,312,081
Flour	4,379	126½	4,252½	531.56	467.78	46.78	3,185.12	21.26	6,991,110
Beef	5,025	1,131	3,894	2,196.70	682.97	978.38	......	35.95	5,409,392
Potatoes	5,116	1,386	2,730	2,943.00	78.33	3.73	667.67	37.30	1,398,750
Onions	700	150	550	481.80	7.70	1.65	55.55	3.30	123,750
Oatmeal	44	......	44	3.34	6.65	3.13	30.01	0.88	81,400
Cornmeal	85	......	85	12.75	7.82	3.23	60.01	1.19	139,825
Apples, canned	10	......	10	8.32	0.02	0.04	1.59	0.03	3,150
Apples, dried	183	......	183	46.85	1.65	3.30	130.85	2.57	259,494
Tapioca (26) and cornstarch (13)	39	......	39	0.78	......	......	38.14	0.08	70,980
Butter	58	......	58	6.09	0.58	49.30	0.29	1.74	209,670
Sirup	165	......	165	70.60	......	......	90.60	3.80	168,795
Lard	107½	......	107½	12.90	0.65	89.66	......	4.30	383,775
Rice	26	......	26	3.22	1.92	0.14	20.65	0.14	42,380
Corn, canned	63	......	63	51.22	1.77	0.70	8.32	0.38	21,735
Tomatoes, canned	332	......	332	318.72	2.66	1.33	8.30	1.00	26,560
Macaroni (51) and vermicelli (1½)	52½	......	52½	6.88	4.73	0.15	40.32	0.42	73,815
Milk, fresh	31	......	31	25.61	1.58	1.50	2.00	0.31	12,552
Milk, condensed	31	......	31	7.75	5.27	3.41	13.64	0.93	49,442
Cheese	10½	½	10	3.50	3.30	2.20	0.50	0.50	16,000
Prunes	35	20	15	10.00	0.75	......	4.00	0.25	3,500
Cabbage and sauerkraut	250	50	200	182.00	4.20	0.60	11.00	2.20	31,000
Ham	32	4	28	11.63	4.68	11.00	......	0.76	54,880
Apricots	20	......	20	13.50	0.40	......	6.00	0.12	9,200
Barley	5	......	5	......	0.65	0.14	3.80	0.15	9,000
Peas	4½	......	4½	0.55	1.20	0.08	2.54	0.12	7,043
Raisins	14	4	10	6.45	0.05	......	3.50	0.08	6,153
Chocolate	3	......	3	0.48	0.60	1.50	0.30	0.12	7,950
Totals	18,598	2,908¾	15,689¼	7,120.50	1,413.21	1,657.17	5,343.66	154.82	19,446,960

		Pounds					Grams		
Daily average per man	4.22	66,15⅓%	3.56,84⅓%	733	145	171	550	16	4,416
Counting flour as bread, amount eaten is 4 lb. per man. Per cent of amount eaten	....	......	......	45	9	11	34	1	
Including Table V (salts only) gms.	....	......		733					
Including estimated amounts in Tables VI and VII	5	¾	4¼, (2.8 lb.) water free						

PERCENTAGE OF WASTE

Bacon	1.40	
Pork	8.00	Only 9 pounds were reported, but this was increased in 31 pounds, to include bones, etc.
Bread	3.30	Crusts and small unavoidable wastes
Beef	22.50	19¾ bone, 2¾ fat, and other wastes
Potatoes	27.09	Parings and defective ones
Onions	21.04	Parings and defective ones
Prunes	33.00	Stones and other wastes
Cabbage	45.00	
Ham	12.00	Estimated

ADDITIONAL ARTICLES CONSUMED

	Daily per man	Allowance	Remarks
338 lbs. green coffee	1.23 ounces	1.60 ounces	
8 lbs. tea	0.03 ounce	0.32 ounce	
20 gallons vinegar	0.14 gill	0.32 gill	Allowance is large to allow of a saving to be used in making sauerkraut and pickles in the fall
10 lbs. pepper	0.036 ounce	0.04 ounce	
11 bottled flavoring extracts			
3 lbs. mustard			
24 lbs. baking powder.			
6 lbs. currants			
5 gallons pickles			
4 kegs pickled pigs' feet	....	....	Though containing much energy, it is omitted because composition is unknown, and the actual amount per man is very small

CONSUMPTION AND ALLOWANCE PER MAN

	Daily per man	Allowance	Remarks
4 379 lbs. flour	15.91 ounces	18 ounces	Includes purchases
4,946½ lbs. bread	17.97 "	18 "	
343¾ " pork	1.34 "	1.2 "	
273¾ " bacon	1.00 ounce	2.4 "	
5,025 lbs. beef	18.30 ounces	18.0 "	
5,116 " potatoes	18.50 "	12.8 "	80 per cent of vegetables
700 " onions	2.50 "	3.2 "	20 per cent vegetables
428½ lbs. beans	1.50 "	2.4 "	
763 lbs. sugar	2.70 "	2.4 "	
64 " butter	2.00 "		
137 " lard	0.50 "		
15 gallons sirup	0.40 gill		

A ration(2) is the allowance for the subsistence of one person for one day and varies in components according to the station of the troops or the nature of the duty performed. The *garrison* ration is for troops in garrison or in permanent camps; the *field* ration is for troops in the field with sufficient transportation; the *haversack* ration for troops in the field in active campaign, when transportation is limited; the *travel* ration for troops traveling otherwise than by marching and separated from cooking facilities; the *Filipino* ration for use of the Philippine Scouts, and the *emergency* ration for troops in active campaign for use on occasions of emergency. The commanding officer will determine which of the several prescribed rations is appropriate for the particular service to be performed, and will direct the use of the same, Army Regulations, 1913, p. 1202.

When it becomes necessary to supplement the haversack ration in the exigencies of forced service, by local purchase or by shipments, the commanding general may direct in written orders the issue in kind, to supplement the haversack ration, of such available articles of food as are actually necessary, not in excess of the amounts allowed of corresponding articles in the garrison ration.

The tables on pages 667-668 are taken from the United States Army Regulations, p. 1202(3), which read: "The kinds and quantities of the component articles of the ration and the substitutive equivalent articles which may be used in place of such components shall be as follows":

Colonel Harvard, Medical Corps, U. S. A., in his splendid work on Military Hygiene(4), describes the various rations for the soldier, from which, with his permission, several sections are quoted herewith:

"The garrison ration, as may be seen, admits of many combinations which insure variety. It is comprehensive and elastic, and can be adjusted to any climate. By selecting the most nutritive articles, such as bacon, hard bread or cornmeal, beans, potatoes, dried fruit, butter and sirup, we can obtain from it a maximum fuel value of 5,378 calories, according to Langworthy, or 5,674 calories, according to Wiley. On the other hand, by using such articles as dried fish, soft bread, rice, potatoes, canned tomatoes and dried fruit, the fuel value can be reduced to 2,500 calories. The average garrison ration, habitually consisting of fresh beef, soft bread, beans, potatoes and onions, dried fruit, butter, sirup and sugar (or their nutritive equivalents), weighs 65 ounces and contains 99 grams of fat, 481 of carbohydrates and 157 of proteins, with total fuel value of 3,536 calories(4).

GARRISON RATION[1]

COMPONENT ARTICLES AND QUANTITIES			SUBSTITUTIVE ARTICLES AND QUANTITIES		
			Mutton, fresh	20	ounces
			Bacon[2]	12	"
			Canned meat, when impracticable to furnish fresh meat	16	"
Beef, fresh	20	ounces	Hash, corned beef, when impracticable to furnish fresh meat	16	"
			Fish, dried	14	"
			Fish, pickled	18	"
			Fish, canned	16	"
			Chicken or turkey, dressed, on national holidays when practicable	16	"
			Soft bread	18	"
Flour	18	"	Hard bread, to be ordered issued only when impracticable to use flour or soft bread	16	"
			Corn meal	20	"
Baking powder	0.08	"	Rice	1.6	"
Beans	2.4	"	Hominy	1.6	"
			Potatoes, canned	15	"
			Onions, in lieu of an equal quantity of potatoes, but not exceeding 20 per cent of total issue.		
			Tomatoes, canned, in lieu of an equal quantity of potatoes, but not exceeding 20 per cent of total issue.		
Potatoes[3]	20	"	Other fresh vegetables (not canned) when they can be obtained in the vicinity or transported in a wholesome condition from a distance, in lieu of an equal quantity of potatoes, but not exceeding 30 per cent of total issue.		
			Apples, dried or evaporated	1.28	"
			Peaches, dried or evaporated	1.28	"

[1] Food for troops traveling on United States Army transports will be prepared from the articles of subsistence stores which compose the ration for troops in garrison, varied by the substitution of other articles of authorized subsistence stores, the total cost of the food consumed not to exceed 24 cents per man per day.

[2] In Alaska, 16 ounces bacon, or, when desired, 16 ounces salt pork, or 22 ounces salt beef.

[3] In Alaska the allowance of fresh vegetables will be 24 ounces instead of 20 ounces, or canned potatoes, 18 ounces instead of 15 ounces.

COMPONENT ARTICLES AND QUANTITIES		SUBSTITUTIVE ARTICLES AND QUANTITIES	
Prunes[1]	1.28 ounces	Jam, in lieu of an equal quantity of prunes, but not exceeding 50 per cent of total issue.	
		Coffee, roasted, not ground	1.12 ounces
Coffee, roasted and ground	1.12 "	Coffee, green	1.4 "
Sugar	3.2 "	Tea, black or green	0.32 "
Milk, evaporated, unsweetened	0.5 "	Pickles, cucumber, in lieu of an equal quantity of vinegar, but not exceeding 50 per cent of total issue.	
Vinegar	0.16 gill		
Salt	0.64 ounce		
Pepper, black	0.04 "		
		Cloves	0.014 ounce
Cinnamon	0.014 "	Ginger	0.014 "
		Nutmeg	0.014 "
Lard	0.64 "		
Butter	0.5 "	Oleomargarin	0.5 "
Sirup	0.32 gill		
Flavoring extract, lemon	0.014 "	Vanilla	0.014 "

[1] At least 30 per cent of the issue to be prunes when practicable.

"Fresh meats are ordinarily issued seven days in ten, and bacon three days.

"The garrison ration is often supplemented by articles obtained from the post garden or purchased from the company fund, which largely contribute to give it variety and appetizing value.

"In order to facilitate the supplying of troops and the keeping of accounts, the former system of issue has been replaced by that of purchase.

"All articles of the garrison, travel, or Filipino ration due a company or other military organization, will be retained by the Quartermaster Corps, and credit given to the organization for the money value of these articles at the current price of the articles.

"The stores required by the organization will be purchased from the Quartermaster Corps, and the latter will pay as savings to the organization commander any excess in value of the stores retained over those purchased. At the end of the month, or whenever necessary, the organization commander will settle the account with the Quartermaster Corps, when the savings to the organization, or the amount due to the Quarter-

master Corps, as the case may be, will be paid, and the account certified as required.

"The price of bread, as charged against organizations, is determined by adding together the cost of flour and other ingredients used, the extra-duty pay of the bakery personnel, the cost of the power used in operating the baking machinery, and then dividing by the total number of pounds of bread baked. It follows that the organizations are thus given the benefit of whatever savings accrue from the conversion of flour into bread after deduction of all expenses.

"Money accruing from the 'ration and savings account' of an organization will be spent only for food.

"All articles of the ration required for the supply of troops will be obtained from the Quartermaster Corps when on hand, but should any organization want more of any article than is allowed by regulation, the excess may be purchased elsewhere; or if any article is not in stock, it can likewise be bought elsewhere.

"When necessary to renew reserve rations, or to avoid loss of ration articles that have accumulated, the commanding general or commanding officer, as the case may be, may order the issue of such supplies to troops, not to exceed the ration allowance and only for such time as the interest of the Government requires.

"The value of the garrison ration is estimated at twenty-five cents; the Filipino ration at twenty cents, and the travel ration at forty cents.

"Under circumstances when enlisted men or nurses cannot be furnished with rations in kind, or it is impracticable to carry them, commutation may be allowed at rates ranging from twenty-five cents to $1.50 a day.

"The ration of enlisted men sick in hospital, and of female nurses while on duty in hospital, is commuted at the rate of thirty cents per ration, except that at the general hospital at Fort Bayard, N. M., fifty cents per ration is authorized for enlisted patients therein.

"Other issues of stores, not components of rations, may be authorized when necessary for the public service and made on ration returns approved by the commanding officer, such as soap, candles, matches, toilet paper, towels and ice.

"Ice is issued by the Quartermaster Corps to organizations of enlisted men as follows: for each ration, four pounds, the maximum allowance to any organization or detachment of less than 100 men to be 100 pounds a day, and to organizations of 100 men or more to be one pound a day, per man. The full allowance may be issued for the entire year to troops

stationed south of the 37th parallel. To troops stationed north of the 37th parallel, and where from any cause it is impracticable to cut and store ice for their use, the allowance will be only for the summer months, from April 1 to October 31. A special allowance is provided for States on the Pacific Coast(4)."

FIELD RATION

COMPONENT ARTICLES AND QUANTITIES			SUBSTITUTE ARTICLES AND QUANTITIES		
Beef, fresh, when procurable locally	20	ounces	Mutton, fresh, when procurable locally	20	ounces
			Canned meat	16	"
			Bacon	12	"
			Hash, corned beef	16	"
Flour	18	"	Soft bread	18	"
			Hard bread	16	"
Baking powder, when ovens are not available	0.64	"			
Yeast, dried or compressed, when ovens are available	0.04	"			
Beans	2.4	"	Rice	1.6	"
			Potatoes, canned	12	"
Potatoes, when procurable locally	16	"	Onions, when procurable locally, in lieu of an equal quantity of potatoes, but not exceeding 20 per cent of total issue.		
			Tomatoes, canned, in lieu of an equal quantity of potatoes, but not exceeding 20 per cent of total issue.		
Jam	1.4	"			
Coffee, roasted or ground	1.12	"	Tea, black or green	0.32	"
Sugar	3.2	"			
Milk, evaporated, unsweetened	0.5	"			
Vinegar	0.16	gill	Pickles, cucumber, in lieu of an equal quantity of vinegar, but not exceeding 50 per cent of total issue.		
Salt	0.64	ounce			
Pepper, black	0.04	"			

The field ration is the ration prescribed in orders by the commander of the field forces. It consists of the reserve ration in whole or in part, supplemented by articles of food requisitioned or purchased locally, or shipped from the rear, provided such supplements or substitutes corre-

spond generally with the component articles or substitutive equivalents of the garrison ration (Army Regulations, 1913, par. 1205).

HAVERSACK RATION

COMPONENT ARTICLES AND QUANTITIES			SUBSTITUTIVE ARTICLES AND QUANTITIES[1]
Bacon	12	ounces	
Hard bread	16	"	
Coffee, roasted and ground	1.12	"	
Sugar	2.4	"	
Salt	0.16	"	
Pepper, black	0.02	"	

[1] We would recommend the use of malted milk tablets as an addition to the haversack field and travel ration of the soldier. We have personally used these and feel assured that they would be a valuable addition from the viewpoint of compactness, solubility and the nutrient energy contained.

"The haversack ration is issued to troops in the field when beyond the advance supply depots. It contains about 218 grams of fats, 489 of carbohydrates and 113 of proteins, with total fuel value of 4,448 calories. Should it be found practicable to supplement it by local purchase or otherwise, the commanding general may direct the issue in kind of such additional articles of food as are available, at whatever cost, but not in excess of the amounts allowed of corresponding articles in the garrison ration.

"The bacon is contained in a rectangular tin can with capacity for two rations. The sugar, coffee and salt are contained in another rectangular tin can, two and one-half inches square, five inches long, and with rounded corners; a cross partition divides it in two compartments, for three days' rations of coffee and sugar; the ends are closed with screw covers. The screw cover on the sugar compartment has a round receptacle two inches in diameter, one-half inch deep, closed with a compression friction top, for carrying three days' rations of salt.

"In the field, bacon, in the absence of fresh meat, becomes an invaluable component of the ration, easily kept and transported, readily digested when well cooked, and furnishing abundant energy for severe muscular work. A quarter ounce of soap per ration is also issued (in ounce cakes).

"Existing orders prescribe that one day in each alternate month of the season of practical instruction, not exceeding three days in each year, the use of the haversack ration, with individual mess-kit, will be required of all troops in the field for purposes of instruction(4)."

TRAVEL RATION

COMPONENT ARTICLES AND QUANTITIES			SUBSTITUTIVE ARTICLES AND QUANTITIES		
Soft bread	18	ounces	Hard bread	16	ounces
Beef, corned	12	"	Hash, corned beef	12	"
Beans, baked	4	"			
Tomatoes, canned	8	"			
Jam	1.4	"			
Coffee, roasted and ground	1.12	"			
Sugar	2.4	"			
Milk, evaporated, unsweetened	0.5	"			

The fuel value of this ration is about 2,735 calories.

FILIPINO RATION

COMPONENT ARTICLES AND QUANTITIES			SUBSTITUTIVE ARTICLES AND QUANTITIES		
			Bacon	16	ounces
Beef, fresh	12	ounces	Canned meat	8	"
			Fish, canned	12	"
			Fish, fresh	12	"
Flour	8	"	Hard bread	8	"
Baking powder, when in field and ovens are not available.					
Rice	20	"			
Potatoes	8	"	Onions	8	"
Coffee, roasted and ground	1	"			
Sugar	2	"			
Vinegar	0.08	gill			
Salt	0.64	ounce			
Pepper, black	0.02	"			

"The components of the ration yield a maximum fuel value of 3,980 calories. As is well known, Filipinos, like other Oriental races, manifest a marked preference for rice, to the exclusion of more nutritious food, thereby rendering themselves liable to beriberi. To guard the scouts against such possibilities, it is prescribed that only unpolished rice be issued to them and that no more than sixteen ounces per day be used. They are also required to use the entire meat allowance. For the portion of the rice ration not drawn, 1.6 ounces of beans are substitued, while native products, such as camotes, mangoes and squash, are utilized to as large an extent as possible(4)."

Savings.—All articles of the garrison and travel ration due a company or other organization, will be retained by the quartermaster and credit

given to the organization for the money value of these articles at the current price of the articles; and the quartermaster will pay as savings to the organization commanders any excess in value of the stores so retained over those purchased by the organization. Such savings shall be used solely for the purpose of articles of food.

In time of peace the ration savings privilege, with the exception hereinafter noted, will be suspended for troops on the march. The ration to be issued to troops on the march in time of peace will be prescribed by the commander and will not exceed the allowances prescribed for the garrison ration. When so ordered by such commander, the savings privilege on certain specified articles of the ration will be allowed(5).

EMERGENCY RATION

An emergency ration, prepared under the direction of the War Department, will be issued, in addition to the regular ration, as required for troops on active campaign or in the field for purposes of instruction, and will not be opened except by order of an officer or in extremity. Company and detachment commanders are responsible for the proper care and use of emergency rations carried on the person of the soldier.

"The emergency ration used in our service, prior to 1910, weighed twelve ounces net and consisted of wheat, meat, chocolate and seasoning. Its preparation was so elaborate as to require special plants, so that, in case of mobilization on a large scale, the supply would have been inadequate. The components of the present ration are such as to be readily obtained and prepared to any extent needed(4). They are as follows:

Chocolate liquor	45.45	per cent
Nucleo-casein	7.25	" "
Malted milk	7.25	" "
Egg albumin	14.55	" "
Powdered cane sugar	21.82	" "
Cocoa butter	3.64	" "

The chemical analysis shows:

Protein	25.24	per cent
Amino-bodies	.88	" "
Fat	28.05	" "
Carbohydrates	39.11	" "
Caffein and theobromin	.17	" "
Ash	3.27	" "

"Each ration weighs eight ounces net and is put up in three cakes of equal size, each cake wrapped in tinfoil, and all three inclosed in a her-

metically sealed and lacquered round-cornered tin, with key-opening attachment. Its fuel value is 1,272 calories, and its cost forty cents.

"From previous experiments it is believed that this ration can be kept in store, even in the tropics, for several years without loss or deterioration. As a compact and portable food preparation, intended to tide over a day or two until regular supplies are available, it is undoubtedly well adapted to its purpose. However, there is serious doubt of its necessity, and the Infantry Equipment Board of 1912 recommended that it be abolished and replaced by the haversack ration, a recommendation that has not yet been approved(4)."

SELECTION OF RATIONS

Concerning the selection of a ration, Woodruff says:

> An army must be fed at a great distance from the market, and it is, therefore, evident that the chief objects in view in the selection of the soldier's food must be facility of transportation and ease of preservation in all climates. Articles that are bulky or easily damaged by rough handling, and those that are not easily preserved from decay, are at once ruled out. It need scarcely be mentioned that the articles must be produced in abundance throughout the country, neither imported nor the particular preparations of a few manufacturers. Couple with this the fact that the articles must be so inexpensive as to refute any charges of extravagance, and it will be readily understood that with a few exceptions the ration contains about all the articles that it is possible to put in at present without calling on foods that are preserved, canned, or otherwise specially prepared.

Concentrated Foods.—The one great objection to prepared foods is the ease with which adulterations and other frauds can be perpetrated. Quality of foods can be easily determined if seen in the natural state, but let them be ground up and mixed with other things, and fraud will be difficult to detect. It is a fact that contractors for army food, knowing that the lives of the soldiers and the safety of the nation may depend on the character of the army supplies, will yet jeopardize the lives of thousands of men by fraudulently supplying inferior articles. The military history of the United States furnishes a host of illustrations. Operations and even campaigns have been hampered or made disastrous by faulty food.

Another objection to concentrated foods as a sole and continuous diet is the fact that they do not furnish sufficient bulk. They may contain the proper amounts of energy and alimentation, yet they can never be

used exclusively. They are not intended to be so used except in emergencies and for short periods.

Company Dietaries.—We give below a week's bill of fare furnished by two different company commanders. The first is very liberal, and the latter far below the normal standard. In contrast, they exemplify in the most fortunate way some of the remarks previously made as to the conditions of service varying the bill of fare:

COMPANY DIETARY AT A WESTERN FORT

MONDAY

Breakfast: Beef stew; fried potatoes; corn bread; sirup; bread; butter; coffee.

Dinner: Meat pie; mashed potatoes; turnips; cabbage; pickled pork; bread; coffee.

Supper: Beefsteak with onions; squash pie; bread and coffee.

TUESDAY

Breakfast: Roast beef; fried potatoes; bread; butter; coffee.

Dinner: Pea soup; roast beef; baked potatoes; stewed onions; cauliflower; tapioca pudding; bread and coffee.

Supper: Meat stew; fried carrots; apple pie; bread; coffee.

WEDNESDAY

Breakfast: Oatmeal; milk; meat hash; bread; coffee.

Dinner: Sauerkraut; pickled pork; mashed potatoes; pickled beets; rice pudding; bread and coffee.

Supper: Fried sausage meat; fried potatoes; green corn; blancmange pudding; bread and coffee.

THURSDAY

Breakfast: Beefsteak with onions; fried potatoes; bread; coffee.

Dinner: Roast beef; mashed potatoes; stewed onions; pickled beets; plum pudding; bread and coffee.

Supper: Fried liver and bacon; fried carrots; squash pie; bread; coffee.

FRIDAY

Breakfast: Beefsteak; fried potatoes; bread; butter; coffee.

Dinner: Pork and beans; peach pie; bread; coffee.

Supper: Cold beef; corn bread; sirup; apple sauce; bread; coffee.

SATURDAY

Breakfast: Meat hash; oatmeal; milk; bread; butter; coffee.

Dinner: Vegetable soup; mashed potatoes; roast beef; pickles; tapioca pudding; bread; coffee.

Supper: Beef stew; green-apple pie; bread; butter; coffee.

SUNDAY

Breakfast: Roast beef; baked potatoes; hot rolls; sirup; bread; butter; coffee.

Dinner: Sauerkraut; pickled pork; mashed potatoes; roast beef; bread; coffee.

Supper: Meat pie; rice pudding; bread; butter; coffee.

(Gravy always served with meats, and sauce with puddings.)

COMPANY DIETARY AT A SOUTHERN POST

MONDAY
Breakfast: Beef hash (with onions and potatoes); bread; coffee.
Dinner: Rice and tomato soup; roast beef; roasted potatoes; bread.
Supper: Beef (same as dinner); bread; coffee.

TUESDAY
Breakfast: Irish stew; bread; coffee.
Dinner: Pea soup (with toasted bread); roast beef; boiled potatoes; bread.
Supper: Beef; pancakes; sirup; bread; coffee.

WEDNESDAY
Breakfast: Meat hash (with potatoes and onions); bread and coffee.
Dinner: Roast beef; mashed potatoes; plum pudding; bread and coffee.
Supper: Fried liver and bacon; bread and coffee.

THURSDAY
Breakfast: Beef hash; bread and coffee.
Dinner: Baked fresh pork; baked beans; bread and coffee.
Supper: Beefsteak; fried potatoes; bread and coffee.

FRIDAY
Breakfast: Irish stew; bread and coffee.
Dinner: Rice and tomato soup; roast beef; boiled potatoes; bread.
Supper: Beef; fried potatoes; bread and coffee.

SATURDAY
Breakfast: Beef hash; bread and coffee.
Dinner: Rice and tomato soup; roast beef; boiled potatoes; spiced bread dressing; bread.
Supper: Meat pot-pie; bread and coffee.

SUNDAY
Breakfast: Fried pork; fried potatoes; bread and coffee.
Dinner: Pea soup, with toasted bread; roast beef; boiled potatoes; bread.
Supper: Beef; fried potatoes; bread; coffee.

(Gravy always served with meats, and sauce with puddings.)

Tropical Dietaries.—There has been but little change in the army ration during recent years, except when controlled by climatic conditions; the army in a cold climate cannot thrive on the same diet that an army in the tropics would do well on, and vice versa. In a cold climate articles of the dietary, subjected to extreme temperatures, will be spoiled by freezing and must be eliminated from the ration. This will exclude potatoes, fresh vegetables, and canned goods that are in liquid form. On the other hand, in the tropics food that excessive heat would spoil or that cannot be safely preserved must be avoided. The ration under such circumstances will have to be so arranged that it may be readily suitable for climatic changes.

It is well known that our army in the Philippines lived on less food than they would require in a cold or temperate climate. This difference is marked, more especially, in the consumption of meat and fatty foods. Of course, if an army is undergoing active service on prolonged marches,

the meat allowance will have to be correspondingly increased to make up for the wear and tear of the muscular system. In the Surgeon-General's Report of the United States Army for 1900, Major Kean is quoted.

He premises that a tropical dietary, as compared with one suited to a colder climate, should have less fat and more carbohydrates, less stimulating proteins in the form of meat, a greater variety of diet both of meats and carbohydrates in the form of fresh vegetables and fruits, and, lastly, a fairly liberal supply of ice. His argument for the substitution of carbohydrates for fats is that the digestion is weakened in hot climates and the liver is inclined to torpidity, while ingested fats are prone to split up into butyric, caproic, and other irritating acids, which the diminished secretion of the liver is unable to neutralize. As intestinal digestion cannot proceed in the presence of acidity, the condition known as biliousness is established, with putrefaction of the intestinal contents and the production of various harmful alkaloid substances. A catarrhal inflammation of the bowel results, with diarrhea, which is at first of advantage in eliminating the harmful substances, but which under the continued irritation of unsuitable diet is liable to continue and become aggravated. As to a lessened use of meat, he cites the dietary customs of the inhabitants of hot climates, who get their proteins less from meat than from the leguminosæ. The appetite is lessened by long and continued heat and becomes capricious. It craves variety, especially in vegetables and fruits, and these he claims cannot be had on the basis of our present ration. The need of ice to furnish a cool drinking water and to preserve the perishable constituents of the ration is regarded as obvious.

In a previous chapter (Volume II, Chapter XII) we have discussed the subject of diet in tropical countries and to this the reader is referred. From what has been advanced in this section, it will be seen that the proportionate composition and fuel value of the proposed standard dietary for troops serving in the tropics should be about as follows:

Protein	100	grams
Fats	65	"
Carbohydrates ..	650	"
Fuel value......	3,491	calories

This would give a nitrogen content of 16 grams and a nutrient ratio of protein energy, 1.8. The proximate alimentary principles whose quantities and relative proportions are represented in the above nutrient standard for the tropics can be properly apportioned in the ideal ration for hot climates, only as a result of an accurate knowledge of the percentage com-

position of such articles of food as may be selected to enter into its composition.

According to Munson(6), the determination of these foodstuffs for the American soldier is an easy task. The present United States army ration is made up of admirably selected articles, in more than sufficient variety. It is, therefore, not only wholly unnecessary, but quite inadvisable, to consider in this connection any nutritive substances outside those articles legally established as components of food for the United States soldier.

Munson suggests the following tables for tropical dietaries. These tables show the nutrient value of a proposed dietary for the tropics containing the greatest amount of food material which can be drawn by the soldier:

TABLE I

TROPICAL DIETARY

Articles	Quantity: Ounces	Fats: Grams	Carbohydrates: Grams	Protein: Grams	Nitrogen: Grams	Fuel Value: Calories
Fresh beef.........	10	44.75	.....	41.68	6.67	590
Flour..............	18	5.60	380.46	55.08	7.90	1,850
Beans..............	2.4	1.22	40.18	15.16	2.42	240
Potatoes...........	16	.45	81.70	9.50	1.52	380
Dried fruit.........	3	1.53	33.80	1.77	.27	220
Sugar..............	3.5	.....	94.25	.....	.....	397
Total..........	52.9	53.55	630.39	123.19	18.78	3,677

Total carbon, 395.14 grams; nitrogen to carbon, 1:19.6.

The following table shows a dietary proposed by Munson, especially applicable to tropical field service, in which the fatty constituents attain their maximum and the potential energy is high:

TABLE II

TROPICAL DIETARY

Articles	Quantity: Ounces	Fats: Grams	Carbohydrates: Grams	Protein: Grams	Nitrogen: Grams	Fuel Value: Calories
Bacon..............	6	105.06	.....	15.64	3.49	1,042
Hard bread.........	18	6.63	371.81	73.12	11.74	1,926
Beans..............	2.4	1.22	40.18	15.16	2.42	240
Dried fruit.........	3	1.53	50.70	1.77	.27	220
Sugar..............	3.5	.....	94.25	.....	.....	397
Total..........	32.9	114.44	556.94	105.69	16.92	3,825

Total carbon, 328.76 grams; nitrogen to carbon, 1:23.

The following is an outline of the ordinary dietary, which Munson proposes for garrison duty in the tropics:

TABLE III

TROPICAL DIETARY

Articles	Quantity: Ounces	Fats: Grams	Carbo-hydrates: Grams	Protein: Grams	Nitrogen: Grams	Fuel Value: Calories
Fresh beef.........	10	44.75	.....	41.68	6.67	590
Soft bread.........	20	6.80	299.20	53.83	8.61	1,506
Potatoes and onions.	16	.72	73.09	8.60	1.40	340
Dried fruit.........	3	1.53	50.70	1.77	.27	220
Sugar.............	3.5	.....	94.25	.....	.....	397
Total..........	52.5	53.80	517.24	105.88	16.95	3,053

Total carbon, 328.76 grams; nitrogen to carbon, 1.18.

In the following dietary have been selected the components most closely approximating the character of the foods usually consumed by the natives of tropical countries, proportioned in the ternary food elements common to hot climates:

TABLE IV

TROPICAL DIETARY

Articles	Quantity: Ounces	Fats: Grams	Carbo-hydrates: Grams	Protein: Grams	Nitrogen: Grams	Fuel Value: Calories
Fresh fish (cod) whole	14	.79	.....	31.73	5.07	120
Soft bread.........	20	6.80	299.20	53.83	8.61	1,506
Rice...............	4	.45	88.87	8.75	1.40	407
Potatoes and tomatoes.............	16	.54	65.80	8.17	1.36	297
Dried fruit.........	3	1.53	50.70	1.77	.27	220
Sugar.............	3.5	.....	94.25	.....	.....	341
Total..........	64.5	10.11	598.82	104.25	16.71	2.947

Total carbon, 327.50 grams; nitrogen to carbon, 1:19.6.

The average of the four dietaries in the mean nutrient composition is outlined below, showing the composition and proportion of the ternary food elements, the nitrogen content and fuel value:

AVERAGE NUTRIENT COMPOSITION

Dietary	Quantity: Ounces	Fats: Grams	Carbo-hydrates: Grams	Protein: Grams	Nitrogen: Grams	Fuel Value: Calories
No. I............	52.9	53.55	630.39	123.19	18.78	3,677
No. II............	32.9	114.44	556.94	105.69	16.92	3,825
No. III............	52.5	53.80	517.24	105.88	16.95	3,053
No. IV............	64.5	10.11	598.82	104.25	16.71	2,947
Average.......	50.7	37.97	560.85	109.06	17.34	3,375

Total carbon, 350 grams; nitrogen to carbon, 1:20.

It will be observed, from a careful study of Munson's tropical dietaries, that while they differ considerably, yet on the average they do not vary greatly from the nutritive standard of ordinary tropical dietaries, which is an additional reason for varying the articles of the ration from day to day. Even this average dietary, as compared with nutrient standards, is still slightly deficient in fats and fuel value and a trifle low in protein. These defects, if they are so considered, may be corrected by rotating their order, so that Dietary II is used twice where Dietaries I, III and IV are each employed but once. The results of this change are as follows:

Dietary	Quantity: Ounces	Fats: Grams	Carbo-hydrates: Grams	Protein: Grams	Nitrogen: Grams	Fuel Value: Calories
No. I............	52.9	53.55	630.39	123.19	18.78	3,677
No. II............	32.9	114.44	556.94	105.69	16.92	3,825
No. III............	52.5	53.80	517.24	105.88	16.95	3,053
No. IV............	64.5	10.11	598.92	104.25	16.71	2,947
Average.......	47.1	69.43	572.06	108.38	17.26	3,465

Total carbon, 363.33 grams; nitrogen to carbon, 1:21.

From a study of the above tables, it is apparent that certain changes are advisable in the adaptation of the United States army ration to tropical conditions. The change could be admirably made by reducing the allowance of potatoes, fats and bread, and substituting succulent vegetables and fruits. The sugars and starches might be slightly augmented, but their increase is small when compared with the considerable reduc-

tion of nitrogenous and fatty material which is proposed. Many of the components of the present ration, as is seen by the following table, require no change in the consideration of the tropical dietary, being not only admirably selected but also properly proportioned.

It is true that the needs of the economy, as shown by appetite, are subject to wide variation. Hence it may be accepted that slight, but carefully considered changes in the constituents of the daily dietary, far from being detrimental, are productive of actual benefit. It is also obvious that the soldier will require less nutriment in garrison than is necessary to furnish the energy for the greater labors of campaign, and hence the several components of the ration should be proportioned to furnish dietaries properly varying in potential and nitrogenous value. This is accomplished in the foregoing modifications of the dietaries shown in tables I to IV:

COMPONENT PARTS UNITED STATES ARMY RATION

Articles	Quantity per Ration: Ounces	Protein: Grams	Nitrogen: Grams	Fats: Grams	Carbohydrates: Grams	Fuel Value: Calories
Fresh Beef (quarters)	10	41.68	6.67	44.75	......	590
Or Fresh Mutton	10	46.20	7.35	62.90	......	720
" Pork	6	27.54	4.40	112.54	......	1,093
" Bacon	6	15.64	2.49	105.06	......	1,042
" Salt Beef	10	40.27	6.44	64.68	......	688
" Dried Fish (cod)	10	45.37	7.26	1.13	......	197
" Fresh Fish, average (whole)	14	31.73	5.07	.79	......	120
Flour	18	55.08	7.90	5.60	380.46	1,850
Or Soft Bread	20	53.83	8.61	6.80	299.20	1,506
" Hard Bread	18	73.12	11.74	6.63	371.81	1,926
" Corn Meal	20	50.40	7.99	12.40	425.80	1,986
Beans	2.4	15.16	2.42	1.22	40.18	240
Or Peas	2.4	16.38	2.62	.75	41.80	246
" Rice	4	8.75	1.40	.45	88.87	407
" Hominy	4	9.20	1.47	.67	88.75	430
Potatoes	16	9.50	1.52	.45	81.70	380
Or Potatoes 80 per cent and Onions 20 per cent	16	8.60	1.40	.72	73.09	340
" Potatoes 70 per cent and Canned Tomatoes 30 per cent	16	8.16	1.30	.58	62.59	297
Dried Fruit (average)	3	1.77	.27	1.53	33.80	220
Sugar	3.5	.....	.....	.....	94.25	397
Or Molasses	1 gill	.....	.....	.....	56.05	269
" Cane Sirup	1 "	.....	.....	.....	56.25	269

Army Rations Past and Present.—In the past, when army rations were planned, it was with a view of keeping the soldier on the smallest amount

of food with the least expenditure of money. In fact, military authorities of the last century believed that to keep a soldier up to a proper discipline he should be clothed roughly, given the simplest kind of overcrowded barracks, and fed like a hog, every modern improvement being considered enervating. Could any of these dead officers see the dining rooms of some of our modern barracks, they would surely think that the service was going to the dogs. It has been elsewhere remarked that when hardships slowly reduce vitality, the man is made less able to exist under more privation in the field. When there are no luxuries and everything has to be plain in order to be durable and serviceable, it is utter nonsense to talk of the enervating effects of luxuries. The present policy of improving the soldier's table service certainly improves the ration on principles known to every physiologist.

The smallest amount of food that will keep a man alive has been approximately known for centuries, and though modern experiments make

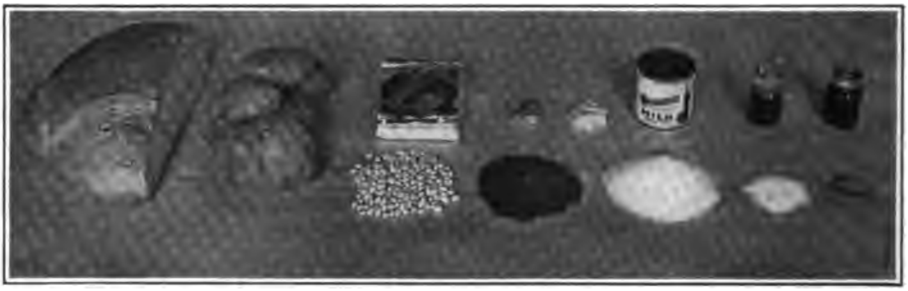

FIG. 12.—COMPONENT PARTS OF A DAY'S RATION OF THE UNITED STATES SOLDIER, WHICH REPRESENTS A FOOD OR FUEL VALUE OF 4,199 CALORIES. (Courtesy of the American Museum of Natural History, N. Y.)

our knowledge vastly more detailed, accurate and scientific, they have added little to the knowledge that a man can subsist on one pound of bread and 1¼ pounds of meat daily for quite a long period. When we come to discuss the amount and kind of food necessary to keep him in health, we are on debatable ground. We all know men whose usual daily food is even more simple than the army ration, but we know, also, that there are times, as during occasional visits from home, when they eat other things that perhaps restore the balance. Patients have often been restored to health by a change of diet made necessary by a recommended change of scene. The soldier's diet should be such as will maintain him in the best physical condition regardless of the varied circumstances under which he may be compelled to live. There never was economy in underfeeding soldiers. In all the wars of the past, the number of sick and

those dead from disease due to improper food has been larger than the mortality due to the enemy's bullets. Underfeeding or improper feeding undoubtedly leads to excessive use of liquor and consequent dissipation, which is disastrous to the health and efficiency of the troops. My observation[1] is that many soldiers of the Civil War formed habits of dissipation from which they suffered until death. These bad habits, I am quite sure, result only from poor food.

The enormous number of cases of rheumatism in veterans occurring during and after the late war may not be due entirely to exposures from army life, as popularly supposed. These men were hardened to exposure, and should never have had more rheumatism than hunters, trappers and the aboriginal Indians. The limited and insufficient ration, and the absence of fresh articles of food, were, no doubt, etiological factors of importance. Indeed, new facts are continually being brought forward, showing new relations between disease and the habitual diet of a patient. Diet in its relation to diseased states is now an all important item of therapeutics. It is seriously questioned whether the bare, unadorned and unvaried ration, as issued, will tend towards the maintenance of perfect health and the greatest efficiency in the soldier.

During our Civil War the ration was largely increased, and among other components thirty pounds of fresh potatoes were added to every 100 rations "where practicable" to issue same. The reports of general officers during the war indicated that with this increased ration the men were overfed, and the law authorizing the issue of potatoes was repealed in 1864, and the ration reduced practically to what it was at the commencement of the war. In 1890, one pound of "fresh vegetables" was added to the ration by law. The experience of the Spanish War indicated that the regulation ration, made up of many substitutive equivalents, was not suitable for the field, and in 1901 it was changed, a special ration being prescribed for the field. Unquestionably this special ration is in excess of requirements, and it is doubtful if sufficient transportation can be provided to carry it in a modern war.

The quantity of stores required for one day's subsistence of 150,000 men in the field is: hard bread, 150,000 lbs.; bacon, 78,750 lbs.; canned beef, 45,000 lbs.; sugar, 30,000 lbs.; desiccated vegetables (potatoes and onions), 11,250 lbs.; roasted and ground coffee, 12,000 lbs.; tomatoes, 15,000 lbs.; beans, 22,500 lbs.; jam, 13,125 lbs.; vinegar, 1,500 gals.; salt, 6,000 lbs.; soap, 6,000 lbs.; candles, 2,250 lbs.; pepper, 375 lbs.

[1] G. A. Kreider.

The total net weight of this amounts to 405,750 lbs., the gross weight to 520,140.23 lbs., and it would form a pyramid 30.58 feet square at the base and 43.75 feet high. To transport the stores would require approximately 15 freight cars of 40,000 lbs. capacity, or 214 army wagons.

Practically all the armies of the world, in the past, have been fed on the same general principles. There is little doubt that the dryness and sameness of the ration is a great factor in the production of the tendency of drunkenness proverbial among soldiers and sailors.

RATIONS FOR BOYS' MILITARY TRAINING CAMPS[1]

Statistics of normal food consumption in the adult are readily available, particularly so during the past few decades, in which a far reaching interest in the problem of human nutrition has engrossed the attention of physiologists and biological chemists.

The rapid progress which has recently been made in infant feeding has thrown light upon the dietetic needs of the human individual in early life. In fact, pediatric literature abounds in well established facts pertaining to the caloric requirements of the infant; but there is, on the contrary, a singular dearth of statistical information pertaining to the actual food requirements and dietary habits of the young adolescent. In fact, both the physiology and pathology of the adolescent period offer a fertile field with abundant opportunity for research to extend this knowledge.

Dubois has done some splendid work in this particular field, having shown by calorimetric experiment at the Russell Sage Institute of Pathology, that the actual food requirements of young boys is twenty-five per cent above that of the adult. The pubescent period in both sexes is marked by great physical growth and development.

The alimentation, at this period, to meet the demands for wear and tear, growth, and development, should be very rich in easily digested *proteins.* There is no period in man's existence when there is greater need for suitable, wholesome, nutritious alimentation—that which will supply the necessary energy for the daily wear and tear of the body, together with the requisite elements for growth and development—than at this period.

The adolescent youth should have a liberal allowance of whole wheat bread, fresh eggs, wholesome meat and fresh vegetables, and fruits of all

[1] Published by the author in "Military Surgeon," May, 1917(14).

kinds, provided he digests them well, but highly spiced food should be restricted.

A recent investigation by Gephart(7) affords an insight into the actual amount of nourishment taken by more than 300 boys in one of the largest private boarding schools in the United States. The total animal supply for such an institution, containing 355 boys, was computed as follows, in metric tons (2,200 lbs.):

	Protein	Fat	Carbohydrate
Food supply	20.5	25.6	60.5
Waste	3.8	5.4	4.2
Food fuel	16.7	20.2	56.3

The quantity of food, computed on the basis of the individual meal served, appears as follows:

	Pounds	Grams	Calories	Calories (per cent)
Protein	0.1107	50.2	206	14[1]
Fat	0.1332	60.4	562	39
Carbohydrates	0.3717	168.8	692	47
			1,460	100

1 Seventy per cent of this was in animal protein.

The food was of the best quality, and included 193 separate varieties. The cost per meal was 20 cents, or 13.8 cents per thousand calories.

This is twice what the poor man in New York pays for his food. But these growing athletic boys were not satisfied with the conventional 3,000 calories per day. The investigator of their dietary ascertained that beside the 4,350 calories which they consumed daily at the table, they bought 650 additional calories in food at a neighboring store, the principal item being chocolate.

From the tables in Volume II, Chapter XII, we see that a patient in hospital requires a minimum of 1,840 calories if the diet is to maintain the metabolic balance. If he should not be confined to bed, he will require a minimum of 2,168 calories; and these estimates do not take into account any unusual demands made because of the increased wear and tear caused by the disease process. A California farmer's family requires a daily

ration yielding 3,515 calories, while the farm laborer requires 4,100 calories; a mechanic 3,500 calories; a ploughman, 4,000; a boy on a Connecticut college football team requires 5,740 calories; on the Harvard boat crew, 4,620 calories; on the Yale boat crew, 4,070, while a man sawing wood needs 5,700 calories. The fuel to furnish the required energy may be derived from the consumption of proteins, fats or carbohydrates.

Lusk(8) points to the fact that 5,000 calories is the amount of energy a real live American boy needs. A dietary furnishing only 2,800 or 3,000 calories will not sustain the growing youth, as evidenced by the "ravenous" appetite of boys. Lack of appreciation of this fact and failure of providing for it are the contributing causes of undernutrition in young boys.

The facts presented above, based on a liberal series of investigations and observations, rather than a few sparsely scattered data, deserves the attention of all medical men, and, in these days of military preparedness, particularly of the army officer who has charge of rationing boys' military training camps. The author has had some experience with boys in camp and realizes the necessity for a well-balanced ration for these youngsters, particularly with a liberal protein content which is easily digested and readily assimilated.

It was the privilege of the author to be ordered to Fort Terry in August, 1916, for service with the Boys' Military Training Camp. It was part of his duty to inspect daily the kitchens and the cooking and serving of food for the boys. He soon became convinced that the officers who planned the rations, while they did remarkably well under the circumstances, were lacking in experience in rationing young and growing boys. Herewith are produced the menus for the first week of the camp:

BOYS' MILITARY TRAINING CAMP, FORT TERRY, NEW YORK

DIETARY FOR WEEK

	Serving	Grams	Calories	Total Calories
Breakfast, July 7, 1916:				
Corn flakes	5 tablespoonfuls	65	81	
Eggs, boiled	2	100	160	
Bread	2 slices	60	160	
Butter	1 large square	15	120	
Breakfast cocoa / Milk and sugar	1 cup	240 c.c.	279	
			—	800

BOYS' MILITARY TRAINING CAMP, FORT TERRY, NEW YORK
DIETARY FOR WEEK—*Continued*

	Serving	Grams	Calories	Total Calories
Dinner:				
Roast beef	Liberal helping	125	140	
Brown gravy	2 tablespoonfuls	30 c.c.	25	
Stewed peas	3 heaping tablespoons	92	111	
Boiled new potatoes	3 medium-sized	150	145	
Bread	2 slices	60	160	
Butter	1 large square	15	120	
Coffee Milk and sugar	1 cup	240 c.c.	156	
			—	857
Supper:				
Fried bologna	Liberal helping	100	258	
Fried potatoes	" "	50	290	
Stewed apples	3 heaping tablespoons	100	120	
Bread	2 slices	60	160	
Butter	1 large square	15	120	
Coffee Milk and sugar	1 cup	240 c.c.	156	
			—	1,204
TOTAL CALORIES FOR DAY				2,861

	Serving	Grams	Calories	Total Calories
Breakfast, July 8:				
Oatmeal and milk	3 heaping tablespoons	100	201	
Fried pork sausage	2 links	70	328	
Boiled potatoes	1 large	150	145	
Bread	2 slices	60	160	
Butter	1 large square	15	120	
Coffee, tea and sugar	1 cup	240 c.c.	156	
			—	1,110
Dinner:				
Pork and	1 slice	30		
Beans	4 heaping tablespoons	80	294	
Pickles		0	0	
Catsup		0	0	
Stewed tomatoes	2 heaping tablespoons	100	16	
Vegetable soup	6 ounces	180 c.c.	35	
Bread	2 slices	60	160	
Butter	1 large square	15	120	
Coffee Milk and sugar	1 cup	240 c.c.	156	
			—	781
Supper:				
Creamed cheese	Liberal helping	80	364	
Potato salad	3 tablespoonfuls	100	123	
Queen olives	3 large	30	60	
Stewed peaches	3 tablespoonfuls	100	228	
Iced tea	1 glass	240	40	
Bread	2 slices	60	160	
Butter	1 large cube	15	120	
			—	1,095
TOTAL CALORIES FOR DAY				2,986

BOYS' MILITARY TRAINING CAMP, FORT TERRY, NEW YORK
DIETARY FOR WEEK—*Continued*

	Serving	Grams	Calories	Total Calories
Breakfast, July 9:				
Farina	Liberal helping	100	56	
Fried eggs	Two	100	160	
Bread	2 slices	60	160	
Butter	1 large square	15	120	
Coffee / Milk and sugar	1 cup	240 c.c.	156	
			—	652
Dinner:				
Roast pork loin	Liberal helping	100	210	
Stewed corn	2 heaping tablespoons	100	101	
Mashed potatoes	2 heaping tablespoons	100	112	
Bread	2 slices	60	160	
Butter	1 large square	15	120	
Coffee / Milk and sugar	1 cup	240 c.c.	156	
			—	859
Supper:				
Cold sliced ham	1 slice (small)	33	93	
Potato salad	2 heaping tablespoons	100	112	
Jelly fruit, pure	3 " "	125	201	
Iced tea and sugar	1 glass	240 c.c.	100	
Bread	2 slices	60	180	
Butter	1 large square	15	120	
			—	806
TOTAL CALORIES FOR DAY				2,317

Breakfast, July 10:				
Oatmeal and milk	3 heaping tablespoons	100	201	
Pork sausage	2 lengths	70	328	
Bread	2 slices	60	180	
Butter	1 square	15	120	
Cocoa and sugar	1 cup	240 c.c.	279	
			—	1,088
Dinner:				
Corned beef / Cabbage	1 large slice / 3 heaping tablespoons	50 / 100	145	
Boiled potatoes	1 medium size	150	145	
Bread	2 slices	60	160	
Butter	1 square	15	120	
			—	560
Supper:				
Macaroni and cheese	2 heaping tablespoons	140	477	
Stewed tomatoes	2 heaping tablespoons	70	16	
Assorted cakes	3 cakes	150	300	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Coffee / Milk and sugar	1 cup	240 c.c.	156	
			—	1,229
TOTAL CALORIES FOR DAY				2,877

BOYS' MILITARY TRAINING CAMP, FORT TERRY, NEW YORK
DIETARY FOR WEEK—*Continued*

	Serving	Grams	Calories	Total Calories
Breakfast, July 11:				
Corn flakes and milk	4 heaping tablespoons	115	93	
Boiled eggs	2	100	160	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Coffee, Milk and sugar	1 cup	240 c.c.	156	
			—	689
Dinner:				
Roast beef	Liberal helping	125	140	
Fresh stringless beans	" "	120	30	
Boiled potatoes	1 large	150	145	
Stewed tomatoes	2 heaping tablespoons	70	16	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Tapioca pudding	3 heaping tablespoons	110	172	
			—	783
Supper:				
Beef pot roast	Large slice	100	357	
Stewed sweet corn	1 ear	100	100	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Jelly	1 heaping tablespoon	35	113	
Iced tea, sugar	1 glass	240 c.c.	80	
			—	930
TOTAL CALORIES FOR DAY				2,402
Breakfast, July 12:				
Sliced orange	1 good sized	250	96	
Milk toast	2 slices	180	240	
Butter	2 squares	30	240	
Cocoa	1 cup	240 c.c.	279	
			—	855
Dinner:				
Roast mutton	1 large slice	75	234	
Gravy	2 tablespoonfuls	30 c.c.	25	
Stewed peas	3 tablespoonfuls	92	110	
Mashed potatoes	2 tablespoonfuls	100	112	
Bread	2 slices	60	160	
Butter	1 square	15	120	
			—	761
Supper:				
Frankfurters	3 large	100	258	
Potato salad	3 tablespoonfuls	100	123	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Stewed apples	3 tablespoonfuls	80	200	
Coffee, milk and sugar	1 cup	240 c.c.	156	
			—	897
TOTAL CALORIES FOR DAY				2,413

BOYS' MILITARY TRAINING CAMP, FORT TERRY, NEW YORK
DIETARY FOR WEEK—*Continued*

	Serving	Grams	Calories	Total Calories
Breakfast, July 13:				
Fried bacon	2 slices	35	140	
Oatmeal	3 tablespoonfuls	100	201	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Coffee, milk and sugar	1 cup	240 c.c.	156	
			—	777
Dinner:				
Pork and	1 slice	30		
Beans	4 heaping tablespoons	80	294	
Vegetable soup	4 ounces	240 c.c.	35	
Catsup				
Bread	2 slices	60	160	
Butter	1 square	15	120	
Rice pudding	2 heaping tablespoons	110	179	
Milk	1 glass	240 c.c.	157	
			—	945
Supper:				
Pink salmon	2 tablespoonfuls	100	198	
Potato salad	3 tablespoonfuls	100	123	
Iced tea	1 glass	240 c.c.	80	
Queen olives	3 large	30	60	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Fig newtons	3 cakes	85	308	
			—	989

Total Calories for the Day 2,711

The menus have been amplified by showing the quantity of the servings in grams, giving the fuel or energy value of each article of food in calories, and the total calories for each meal, and for each day, averaging in a week 2,652 calories a day. Students of trophodynamics who have given much thought to the dietary requirements of a young American boy know that the above ration is lacking in fuel value, especially so when we remember that the boy requires one-half as much more than a farmer at his occupation, which is strenuous.

Various authorities have estimated the protein requirements as rang-

ing from 60 to 150 grams. Voit's standard was 118 grams; Chittenden thinks 60 grams sufficient; while Atwater's standard at moderate work is 125 grams and at severe work 150 grams. As previously stated, the growing boy needs a larger percentage of available protein in his dietary than the adult. He not only needs it for the necessary wear and tear upon the tissues the same as the adult, but in addition for growth and development. Moreover, the satisfaction of bodily needs does not depend upon protein, but upon *useful protein.* A complete protein contains about twenty amino-acids, and while most animal protein is complete, many vegetable proteins are not.

Therefore, depending upon the variety of protein furnished, it will appear that it may become necessary to consume several times the amount of protein actually catabolized in order to obtain *sufficient useful protein.* Since we cannot consult a chemist daily with regard to the amino-acid components of various proteins, we will err on the side of safety if we ingest slightly more than is absolutely necessary.

Careful experimental research has emphasized the fact that each individual needs a different amount of food, according to his structure and surroundings; he requires protein, carbohydrates, fats and water in addition to mineral salts. It is absolutely essential that certain types of proteins, certain types of fats, and certain salts be included in the dietary. It is recognized at the present time that something more is essential for the maintenance, growth, development, and well being of man than the ternary food elements just mentioned. Foods contain a minute proportion of "accessory substances," generically called vitamines, and when these are deficient or absent from the dietary, the immature body does not grow, while the mature body does not maintain a normal healthy condition and manifestations of disease soon appear.

Unless food contains sufficient vitamine principles, no matter how well balanced the ration may be in the ternary food elements, nor how large quantities are consumed, nor how high the caloric value may be, there will be malnutrition. This is frequently the case among the poor, who consume large quantities of food which is neither proportionately balanced nor sufficiently varied to furnish the requisite vitamine content, and for this reason diseases of malnutrition are common among them.

Below we append a daily menu for one week of what we consider a well balanced ration for a growing boy; this ration will furnish about 125 grams of protein daily and an average of about 4,300 calories.

PROPERLY BALANCED DIETARIES FOR BOYS' MILITARY TRAINING CAMPS

REQUISITE AMOUNTS OF THE TERNARY FOOD ELEMENTS AND FUEL OR ENERGY VALUE IN CALORIES

	Serving	Grams	Calories	Total Calories
Monday Breakfast:				
Orange	1 medium	250	96	
Oatmeal, milk and sugar	3 tablespoonfuls	100	201	
Eggs	2 boiled	100	160	
Fried bacon	2 slices	35	140	
Bread	2 "	60	160	
Butter	1 square	15	120	
Coffee, milk and sugar	1 cup	240 c.c.	156	
Salt, pepper				
			—	1,033
Dinner:				
Creamed pea soup	6 ounces	180 c.c.	243	
Roast beef	1 slice	100	343	
Brown gravy				
Lima beans	2 heaping tablespoons	80	128	
Mashed potatoes	2 " "	100	112	
Lettuce	½ head	200	10	
American cheese	1 ounce	31	136	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Bread pudding	3 heaping tablespoons	155	338	
Cocoa	1 cup	240 c.c.	279	
Salt, pepper, pickles, catsup				
			—	1,863
Supper:				
Lamb or pork chop	1	100	200	
Macaroni and cheese	2 heaping tablespoons	140	477	
Sliced tomatoes	1 medium size	200	46	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Peach pie	⅙ pie	126	352	
Iced tea	1 glass	240 c.c.	80	
Salt, pepper, pickles, catsup				
			—	1,425
TOTAL CALORIES FOR THE DAY				4,321

Tuesday Breakfast:				
Stewed prunes	6	120	312	
Shredded wheat, milk and sugar	1	69	205	
Scrambled eggs	2	100	160	
Baked hash	2 heaping tablespoons	100	140	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Coffee, milk and sugar	1 cup	240 c.c.	156	
Salt, pepper				
			—	1,253

REQUISITE AMOUNTS OF THE TERNARY FOOD ELEMENTS AND FUEL OR ENERGY VALUE IN CALORIES—*Continued*

	Serving	Grams	Calories	Total Calories
Dinner:				
Tomato soup	6 ounces	180 c.c.	186	
Roast lamb	1 slice	100	200	
Baked beans	3 heaping tablespoons	115	152	
Baked potatoes	1 large	150	160	
American cheese	1 ounce	31	136	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Indian meal pudding	2 heaping tablespoons	164	324	
Cocoa, milk and sugar	1 cup	240 c.c.	279	
Salt, pepper, pickles, catsup				
			—	1,817
Supper:				
Cold roast beef	1 medium slice	100	300	
White potatoes	3 heaping tablespoons	145	350	
Cucumbers	8 thin slices	50	9	
Green corn	1 ear	100	100	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Sugar cakes	3	15	75	
Lemonade	1 glass	240 c.c.	150	
Salt, pepper, pickles, catsup				
			—	1,264
TOTAL CALORIES FOR THE DAY				4,334
Wednesday Breakfast:				
Cantaloup	½ medium	465	93	
Oatmeal, milk and sugar	3 tablespoonfuls	100	201	
Eggs	2 soft boiled	100	160	
Broiled ham	1 slice	35	140	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Coffee, milk and sugar	1 cup	240 c.c.	156	
Salt, pepper				
			—	1,030
Dinner:				
Creamed corn soup	6 ounces	180 c.c.	150	
Roast ham	1 large slice	100	210	
Boiled cabbage	3 heaping tablespoons	100	5	
Lettuce	½ head	200	10	
Baked beans, home made	3 heaping tablespoons	115	298	
American cheese	1 ounce	31	136	
Creamed potatoes	4 heaping tablespoons	115	140	
Olives	3 medium	30	60	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Rice pudding	3 heaping tablespoons	165	257	
Cocoa, milk and sugar	1 cup	240 c.c.	279	
Salt, pepper, pickles, catsup				
			—	1,925

REQUISITE AMOUNTS OF THE TERNARY FOOD ELEMENTS AND FUEL OR ENERGY VALUE IN CALORIES—*Continued*

	Serving	Grams	Calories	Total Calories
Supper:				
Steak	1 medium slice	100	185	
Potato chips	3 heaping tablespoons	50	295	
Cream cheese	2 cubic inches	40	180	
Creamed onions	3 small	100	125	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Apple pie	⅙ pie	126	352	
Water	1 glass	240 c.c.	...	
Salt, pepper, pickles, catsup				
			—	1,465
TOTAL CALORIES FOR THE DAY				4,320
Thursday Breakfast:				
Stewed prunes	6 medium	120	312	
Force	5 heaping tablespoons	18	66	
Eggs	2 soft boiled	100	160	
Bacon, fried	2 slices	60	140	
Bread	2 "	60	160	
Butter	1 square	15	120	
Orange marmalade	1 heaping tablespoon	30	115	
Coffee	1 cup	240 c.c.	156	
Salt, pepper				
			—	1,219
Dinner:				
Potato and meat soup	6 ounces	180	210	
Roast beef	1 slice	100	357	
String beans	4 heaping tablespoons	120	26	
Baked potatoes	1 medium size	130	149	
Sliced tomatoes	1 " "	200	46	
American cheese	1 ounce	31	136	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Ice cream	2 heaping tablespoons	100	190	
Chocolate cake	1 medium slice	70	258	
Cocoa	1 cup	240	279	
Salt, pepper, pickles, catsup				
			—	1,929
Supper:				
Pork chop	1 chop	70	113	
Macaroni and cheese	2 heaping tablespoons	140	470	
Sliced beets	2 " "	70	29	
Green corn	1 ear	100	100	
Sliced cucumbers	8 thin slices	50	9	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Peach pie	⅙ pie	126	360	
Salt, pepper, pickles, catsup				
			—	1,361
TOTAL CALORIES FOR THE DAY				4,509

REQUISITE AMOUNTS OF THE TERNARY FOOD ELEMENTS AND FUEL OR ENERGY VALUE IN CALORIES—*Continued*

	Serving	Grams	Calories	Total Calories
Friday Breakfast:				
Peaches	1 average size	128	44	
Oatmeal, milk and sugar	3 heaping tablespoons	100	201	
Eggs	2 soft boiled	100	160	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Toasted cheese	2 ounces	50	250	
Coffee, milk and sugar	1 cup	240 c.c.	156	
Salt, pepper				
			—	1,091
Dinner:				
Creamed pea soup	6 ounces	180 c.c.	243	
Fresh haddock or white fish	Liberal helping	100	108	
Lima beans	3 heaping tablespoons	120	200	
Creamed mashed potatoes	4 " "	115	141	
Sliced tomatoes	1 medium sized	200	46	
American cheese	1 ounce	31	136	
Bread	2 slices	60	180	
Butter	1 square	15	120	
Bread pudding	3 heaping tablespoons	155	337	
Queen olives	3 medium sized	30	60	
Cocoa	1 cup	240 c.c.	279	
Cakes	2	22	94	
Salt, pepper, pickles, catsup				
			—	1,929
Supper:				
Vegetable soup	6 ounces	180 c.c.	24	
Baked beans	4 tablespoonfuls	200	400	
Cheese and macaroni	3 heaping tablespoons	140	441	
Sliced tomatoes	1 medium sized	200	46	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Lemon pie	1/6 pie	110	288	
Lemonade	1 glass	250 c.c.	174	
Salt, pepper, pickles, catsup				
			—	1,325

TOTAL CALORIES FOR THE DAY 4,345

Saturday Breakfast:				
Stewed prunes	6	120	312	
Shredded wheat	1 biscuit	69	205	
Eggs	2 boiled	100	160	
Baked hash	2 tablespoonfuls	100	140	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Coffee	1 cup	240 c.c.	156	
Salt, pepper				
			—	1,253

REQUISITE AMOUNTS OF THE TERNARY FOOD ELEMENTS AND FUEL OR ENERGY VALUE IN CALORIES—*Continued*

	Serving	Grams	Calories	Total Calories
Dinner:				
Creamed corn suet	6 ounces	180	160	
Roast beef	1 slice	100	310	
Cauliflower	3 heaping tablespoons	180	12	
String beans	3 " "	90	18	
White potatoes	3 " "	145	350	
Bread	2 slices	60	160	
Sliced tomatoes	1 medium sized	200	47	
Butter	1 square	15	120	
Rice pudding	3 heaping tablespoons	165	257	
Olives	3 medium	30	60	
Cocoa	1 cup	240 c.c.	279	
Salt, pepper, pickles, catsup				
			—	1,743
Supper:				
Mutton chop	1 chop	100	135	
Potato chips	3 heaping tablespoons	50	295	
Green corn	1 ear	100	100	
Sliced cucumbers	8 thin slices	200	9	
American cheese	1 ounce	31	136	
Bread	2 slices	60	160	
Butter	1 square	15	120	
Peach pie	⅙ pie	126	352	
Lemonade	1 glass	250 c.c.	150	
Salt, pepper, pickles, catsup				
			—	1,564

TOTAL CALORIES FOR THE DAY.................................. 4,560

Sunday Breakfast:				
Cantaloup	½ medium	465	93	
Oatmeal, milk and sugar	3 heaping tablespoons	100	201	
Eggs	2 boiled	100	160	
Breakfast bacon	2 slices	35	140	
Bread	2 "	60	160	
Currant jelly	1 heaping tablespoon	35	113	
Butter	1 square	15	120	
Coffee, milk and sugar	1 cup	240 c.c.	156	
Salt, pepper				
			—	1,143
Dinner:				
Watermelon	1 large slice	300	40	
Bean soup	6 ounces	180 c.c.	70	
Olives	3 medium	30	60	
Roast chicken	Liberal helping	100	273	
Baked potatoes	1 large	150	160	
Radishes	6	50	8	
Sliced tomatoes	1 medium sized	200	46	

REQUISITE AMOUNTS OF THE TERNARY FOOD ELEMENTS AND FUEL OR ENERGY VALUE IN CALORIES—*Continued*

	Serving	Grams	Calories	Total Calories
Dinner:—Continued.				
Green peas	3 heaping tablespoons	92	110	
Bread	2 slices	50	160	
Butter	1 square	15	120	
Bread pudding	3 heaping tablespoons	155	337	
Ice Cream	2 " "	100	189	
Cocoa	1 cup	240 c.c.	279	
Salt, pepper, pickles, catsup				
			—	1,852
Supper:				
Chicken soup	6 ounces	180 c.c.	78	
Baked beans	4 heaping tablespoons	200	400	
Baked macaroni and cheese	2 " "	100	300	
Sliced tomatoes	1 medium sized	200	46	
Green corn	1 ear	100	100	
Bread	1 slice	30	80	
Butter	1 square	15	120	
Peach pie	⅙ pie	126	252	
Salt, pepper, pickles, catsup				
			—	1,476

TOTAL CALORIES FOR THE DAY 4,471

RATIONS OF FOREIGN ARMIES

Colonel Woodruff, writing on this subject(9), worked out a table of comparison of eight countries. He reduced all weights to grams; the amounts of the chemical constituents were calculated, and the results tabulated as given below. Space will not permit an accurate comparison of the analyses given of the rations supplied to the armies of the various European countries, nor the vastly different systems in vogue for supplying the food.

In European countries, fresh meat is expensive; therefore, from economy, the nitrogen in the ration is supplied principally in the form of peas, beans, cheese, etc. In Russia, the meat ration is low, and the deficiency of protein is made up by free allowances of pulses and bread. The American soldier, from custom, requires the stimulating effects of an abundance of good, wholesome, fresh meat, and the United States is the only country which furnishes its soldiers with the whole ration. Other countries furnish part, and the soldier purchases an additional aliment from his pay

or from allowances for this purpose. In England, bread and meat in moderate quantity are supplied, but the soldier must pay for the rest and as much as twenty-five per cent of his pay may be thus deducted. In Germany, he is furnished only bread and must find the rest of his ration, but if the portion is supplied officially, the cost up to three and one-quarter cents is charged against his pay; anything over this is paid by the government.

COMPARATIVE TABLES OF FOREIGN ARMY RATIONS (Woodruff)

Nation	Ration	Proteins	Fats	Carbohydrates	Calories	Remarks
		Gm.	Gm.	Gm.		
1. England	1. Home	93	61	244	1,938	(a)
	2. Foreign station or under canvas at home	111	80	244	2,175	
	3. March	120	80	324	2,550	
	4. War: Maximum	165	128	425	3,634	(b)
	Minimum	133	92	425	3,204	
	Sometimes 2 oz. of rum	...	...	...	175	
2. Spain	1. Peace: Maximum	147	87	588	3,729	(c)
	Minimum	120	62	500	3,421	
	2. War, on march or in the field: Maximum	131	94	522	3,327	(d)
	Minimum	113	55	485	2,550	
	Sometimes 1.7 oz. of brandy	...	...	...	150	
3. Austria	1. Peace	155	125	504	3,865	(e)
	2. War	165	130	504	3,952	
4. Italy	1. Garrison	111	130	600	4,129	(f)
	2. Camp	115	133	600	4,163	
	3. Marching	125	143	600	4,307	
	Usually wine added	...	...	...	250	
5. Germany	1. Small rations and portions in garrison and cantonments:					
	Maximum	150	40	703	3,947	(g)
	Minimum	99	40	502	2,827	
	2. Large rations and portions on march or in maneuvers:					
	Maximum	172	62	915	4,961	
	Minimum	138	57	644	3,744	
	3. Field: Maximum	195	151	703	4,786	
	Minimum	78	75	515	3,413	
	Commanding general may add 3¼ oz. of whiskey	...	...	...	268	

COMPARATIVE TABLES OF FOREIGN ARMY RATIONS—*Continued*

NATION	Ration	Proteins	Fats	Carbohydrates	Calories	Remarks
6. UNITED STATES..	1. By law: Maximum.....	183	260	621	5,368	(h)
	Minimum......	105	103	500	3,712	
	2. Usually in field (by law):					
	Maximum..........	106	320	540	5,166	
	Minimum...........	64	240	460	4,722	
	Average..............	85	280	500	5,000	
	3. Food actually eaten in cold climate, moderate work, including all extras from garden and purchases...........	155	180	597	4,907	
7. FRANCE.........	War: Maximum.......	183	300	690	5,455	(i)
	Minimum........	146	127	520	4,015	
	Add 2 1-10 oz. of brandy	...	...	...	184	
8. RUSSIA..........	1. Peace: Maximum......	233	114	976	5,884	(j)
	Minimum.......	165	65	746	4,450	
	Add 3 oz. of wine......	...	...	...	223	
	2. War: Maximum.......	174	62	805	8,583	(k)
	Minimum........	149	50	640	3,307	
	Add 4⅛ oz. of wine.....	...	...	...	362	

(*a*) This is starvation diet, and the extra food needed for health is purchased and charged against the soldier (about six cents a day), increasing, perhaps doubling, the food value.

(*b*) Can be greatly changed to suit climate.

(*c*) Sufficient for such a mild climate and very moderate work.

(*d*) Varies enormously according to class of rations issued. Very many extra allowances of money for food.

(*e*) This is augmented by four cents a day for vegetables, etc. On the march a limited emergency ration is used. The war ration is so insufficient that commanders of armies or smaller forces may change, supplement, or even double it.

(*f*) Allowances of one-fifth of a cent a day for condiments; occasional extra money allowances for food. Excepting the protein, it is a very liberal diet for so mild a country.

(*g*) This is what the government may supply. Usually the soldier feeds himself and is given seven cents a day or more to reimburse him for the outlay. The food eaten is more than this deficient diet allows.

(*h*) Maximum due to fats if all the bacon is used and no meat. The entire ration is supplied and intended to be eaten.

(*i*) Peace ration not stated. It is purchased as needed and charged against the soldier. War ration is subject to great augmentation for increased work or cold climate. The commanding officer may augment ration on the march.

(*j*) Also allowed money to buy one-half to one and one-half ounces extra meat, and one to one and one-half cents for vegetables, salt, butter, lard, and groceries.

(*k*) Extra meat and spirits may be ordered by the commander-in-chief.

All foreign armies have a so-called *emergency ration,* but, with the exception of England, it is nothing else but a field ration in a more condensed and portable form, consisting of hard bread, and preserved meat and vegetables in cans.

Germany.—"In Germany, four types of rations are also provided, two for peace time and two for the field. The large peace ration, such as

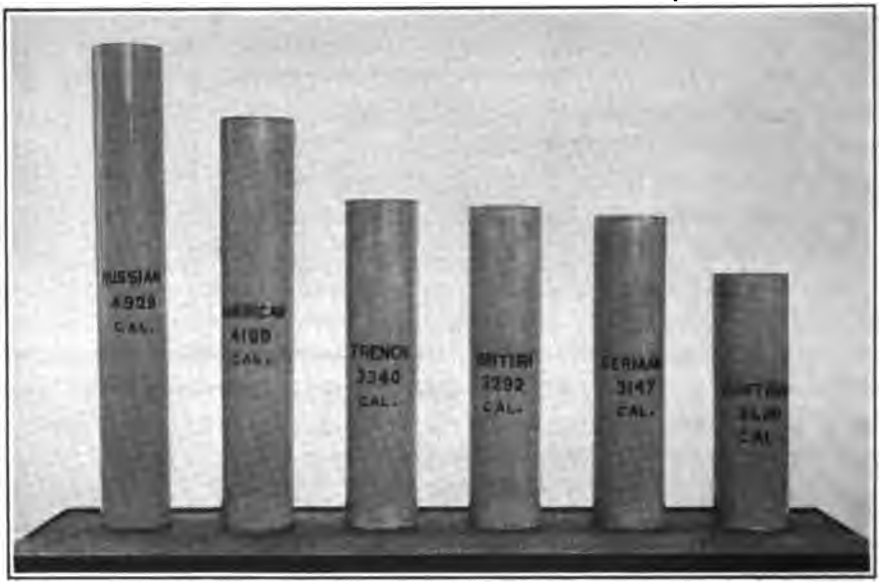

FIG. 13.—COMPARATIVE FUEL VALUE OF THE FOOD RATIONS OF THE SOLDIERS OF THE LEADING ARMIES OF THE WORLD. (Courtesy of the American Museum of Natural History, N. Y.)

issued during maneuvers, consists of 750 grams of bread, or 500 of field biscuit or 400 of egg biscuit; 250 grams of fresh meat, with 60 of kidney fat, or 200 of smoked bacon, or 200 of canned meat; and vegetables. According to Bischoff, its composition is: Protein, 89.9 grams; fats, 80.7; carbohydrates, 514.8; with fuel value of 3,230 calories(13).

"The other peace ration is somewhat smaller and, in certain garrisons, has to be supplemented from the private means of the soldier. The small

field ration averages 141 grams of protein, 51 of fat, and 458 of carbohydrates, with fuel value of 2,929 calories; the large field ration, 181 grams of protein, 64 of fat and 558 of carbohydrates, with fuel value of 3,625 calories. The commissary furnishes bread and meat, most of the other articles being purchased out of a daily allowance of 4 cents per man."

The German soldier takes a cup of black coffee, or coffee with milk, and bread in the morning, dinner at noon, and a light supper in the evening. During maneuvers, or in the field, he may also receive one quart of beer, one pint of wine, or about three ounces of spirits(14).

Russia.—"The Russian soldier(4) in the field receives 2¼ ounces of black bread (from unbolted rye flour), 14½ ounces of fresh meat or 11 of preserved or salt meat, 9 ounces of green vegetables or the equivalent in compressed vegetables, 1 to 2 ounces of suet or butter for cooking, together with 4 to 5 ounces of grits, tea, sugar and condiments. According to Bischoff, its composition is: Protein, 120.7 grams; fat, 39.2 grams; carbohydrates, 628 grams; with fuel value of 3,147 calories."

Most of the articles of the ration (bread excepted) are boiled together in a large wheeled kettle and served as soup.

Japan.—"The Japanese ration, in the field, consists of:

Rice, uncooked	30	ounces
Or steamed and dried	25	"
" fresh bread	20	"
" hard bread	13	"
Meat, canned	10	"
Or fresh (with bones)	13	"
(which may be increased to 20 if procurable)		
" salt, dry or smoked meat	8	ounces
" fish	2	"
Vegetables, dry	8	"
Or green	32	"
Pickles, sauces and condiments		
Tea and sugar		
Sake (beer made from rice)		

"The Japanese soldier does not take readily to bread, either fresh or hard. During the Russo-Japanese War, the meat component was scant and issued irregularly; rice, fish and vegetables formed the staple ration.

"The Japanese medical regulations provide that the nutritive value of the ration shall never fall below 2,580 calories."

France.—"In France, four types of rations are provided, two for peace (garrison ration and maneuver ration), and two for war (ordinary and large field rations).

"The components of the garrison and field rations are as follows:

Articles	Garrison ration	Ordinary field ration	Large field ration
	Kg. Grams	Kg. Grams	Kg. Grams
Soft bread (brown)	0.750	0.750	0.750
Soup bread (white)	0.250	....	....
Fresh beef	0.320	0.400	0.500
Rice	0.030	0.060	0.100
Or pulses	0.060	0.060	0.100
Lard	0.030	0.030	0.030
Or beef suet	0.040	0.040	0.040
Salt	0.015	0.020	0.020
Sugar	0.021	0.021	0.031
Coffee	0.016	0.016	0.024

"The soft bread (*'pain de munition'*) is a leaven-made bread from flour bolted to 20 per cent; it may be replaced by *pain biscuite,* or by hard bread and partly by Italian pastes and flours or cereals; the beef, by any kind of fresh or preserved meat, fish, cheese or milk; the rice and pulses, by any available dry or green vegetables.

"In bivouac, or whenever ordered by the commanding general in the field, a liquid ration is issued of either wine (one-half pint), beer (one pint), or brandy (two ounces)."

The garrison ration contains, according to Rouget and Dopter:

Proteins	125.06 grams,	yielding	513	calories
Fats	60.46 "	"	562	"
Carbohydrates	573.52 "	"	2,351	"
Total			3,426	"

The maneuver ration contains less protein and fat, having a fuel value of 3,164 calories.

The ordinary field ration contains:

Proteins	123.60 grams,	yielding	507	calories
Fats	64.74 "	"	602	"
Carbohydrates	476.99 "	"	1,956	"
Total			3,065	"

Soup bread may be added if available (which is seldom the case), increasing the total calories to 3,687. The fuel value of the large field ration (without soup bread) is 3,383 calories.

The French soldier takes two meals a day, breakfast at 10 A.M. and dinner at 5 P.M., besides black coffee at reveille.

In time of peace, the commissary department supplies only hard bread, sugar and coffee, as well as wine and brandy when authorized. The rest of the ration is purchased by the company messes (*ordinaires*) from special money allowances (about 10 cents per man), under the supervision of a council appointed by the commanding officer (*commission des ordinaires*). Money allowances remaining unexpended, that is, resulting from savings on the ration, as well as proceeds from fines, sale of wastes, etc., are used in purchasing such additional articles of food as are deemed desirable.

In war, the men carry two days' rations in the haversack; two more are carried in the regimental trains, and four on the administrative trains.

The following three or four pages are taken largely from a report on the "Medico-Military Aspects of the European War," by Surgeon A. M. Fauntleroy(11), U. S. Navy (Bureau of Medicine and Surgery, Navy Department, Washington, D. C.).[1] Surgeon Fauntleroy had an excellent opportunity to study conditions in the French lines, many courtesies being extended him in France by Dr. Joseph Blake, formerly of the New York Presbyterian Hospital, and Dr. Alexis Carrell, formerly of the Rockefeller Institute, New York City.

Among other conditions, he investigated the methods of cooking in the trenches. He says: "Each company of about 100 men has its field kitchen, and each man carries with him a tin cup, plate, knife, fork and spoon. For some months after the outbreak of the war the French armies were not supplied with regular field kitchens, but were dependent upon improvised means of cooking food." At the present time, however, a field kitchen of the same type as the English kitchen is in general use. These field kitchens are augmented by improvised ovens, situated as close to the entrance of the *boyau* as is compatible with military conditions. From this situation food is served hot to the men in the trenches, and the efficiency of the commissary department is a large factor in promoting general contentment throughout the French army.

The French ration is an exceedingly liberal one in every way, and no form of wholesome and suitable food is denied the French soldier. Men of all ranks and grades are apparently supremely content with this branch

[1] Used by permission of the Secretary of the Navy.

of the service. Hot coffee and bread are served in the early morning, and hot coffee is also prepared in large quantities, and served throughout the day. This latter is encouraged by the officers, as it not only guarantees the sterility of the water thus boiled, but reduces the necessity of drinking unboiled water.

The principal meal, *déjeuner,* is served in the middle of the day and every precaution is taken to make it a complete and satisfactory repast. In the late afternoon, the evening meal is prepared, and in general, while a little less substantial than the midday meal, it is still quite sufficient. As is well known, the Frenchman has a light breakfast—coffee and rolls.

There are three rations authorized in the French army: The reserve ration, the strong ration, and the normal ration.

COMPOSITION OF THE RATION OF THE FRENCH ARMY

Articles	Reserve ration	Strong ration	Normal ration
Bread:			
Soft	....	1.65 lbs.	1.65 lbs.
Field	....	1.54 "	1.54 "
Hard	0.66 lbs.[1]	1.32 "[2]	1.32 "
Meat:			
Fresh	....	1.10 "	.88 "
Canned (seasoned)	.66 lbs.	.66 "	.44 "
Dried vegetables or rice	....	.22 "	.132 "
Small store:			
Salt	....	.044 "	.044 "
Sugar	.176 lbs.	.0704 "	.0462 "
Coffee, roasted, in tablets	.0792 "	....	....
Coffee, roasted, in tablets or loose	....	.0528 lbs.	.0352 lbs.
Coffee, green	....	.0627 "	.0418 "
Lard (when fresh meat is issued)	....	.066 "	.066 "
Potage salé (when canned meat is issued)	.11 qts.	.11 "	.11 "
Brandy	.055 "	....	....
To each man in bivouac or when specially ordered:			
Wine	....	.2641 qts.	.2641 qts.
Beer	....	.5282 "	.5282 "
Brandy	....	.055 "	.055 "
Tobacco:			
"Caporal," for officers	.044 lbs.	.033 lbs.	.033 lbs.
"Cantine," for enlisted men	.033 "	.033 "	.033 "

[1] Six pieces, or crackers.
[2] Twelve pieces, or crackers.

The greatest possible latitude is allowed in making substitutes with supplies procured by exploiting the local resources. This authority is

vested in all division generals and subordinate commanders. The substitutive articles and quantities of each authorized to be issued in lieu of a ration component are given below:

AUTHORIZED SUBSTITUTIVE EQUIVALENTS

	Strong ration	Normal ration
Substitute for one ration of fresh meat (beef)	1.10 lbs.	0.88 lbs.
Veal, mutton, pork, rabbit, horse, or fresh fish	1.10 "	.88 "
Meat pudding, eggs, soft cheese	.825 "	.66 "
Codfish, salted	.66 "	.55 "
Bacon	.66 "	.55 "
Smoked meat, herring, salted, or salted sardines	.55 "	.44 "
Cheese (Gruyere, Holland, Chester, Roquefort)	.55 "	.44 "
Sausage, small and large, smoked, herring, smoked	.44 "	.33 "
Sardines, in oil	.33 "	.22 "
Codfish, dried, meat powder	.275 "	.22 "
Cow's milk	2.6412 qts.	2.201 qts.
Substitute for one ration of dried vegetables or rice	.22 lbs.	.132 lbs.
Potatoes	1.65 "	.99 "
Turnips, carrots, or cabbage	2.2 "	1.32 "
Sauerkraut	1.32 "	.792 "
Canned vegetables	.264 "	.154 "
Wheat flour	.22 "	.132 "
Italian pastes (noodles, vermicelli, etc.)	.22 "	.132 "
Corn meal	.22 "	.132 "
Cheese, Gruyere, or Holland	.154 "	.088 "
Cheese, soft	.242 "	.132 "

The list gives the substitutes that were in force prior to the commencement of the present war, and it has been greatly augmented since. There is practically no limit to the articles that may be substituted by higher commanders as long as common sense is displayed both in the dietetic properties of the food and the cost to the Government. This matter is regulated in orders issued by army and corps commanders. In these orders the prices of different foodstuffs are fixed, and the farmer or merchant in the theater of operations is given the chance to sell these supplies at or below these figures; otherwise the supplies are formally requisitioned and paid for at the rate stated in the order.

The "extraordinary supplements authorized" can only be authorized by army and corps commanders or by commanders of independent forces. In this case the supplies must be furnished from the chain of supplies moving from the base depot forward, and these are the only commanders

who are in a position to make the arrangements to meet this situation. The extraordinary supplements are as follows:

EXTRAORDINARY SUPPLEMENTS AUTHORIZED

1. One ration of wine, beer, or brandy.
2. Additional: One-third ration of bread. One-fifth ration of meat.
3. Increase of one-half, one-third, one-fourth of the complete "strong" or "normal" ration.

In the first instance, it must be remembered that the substitutes authorized are obtained locally, and therefore no additional drain is made on the regular chain of supplies coming forward. Under "the automatic food supply" system in the French army, one day's complete food supply for the entire army goes forward daily from the regulating station to the railhead, and from that point forward until it arrives at the ration wagon of the organization. If the organization has procured a substitute for one of the component articles locally, it follows that it will not need certain articles carried by the train and about to be issued. It, therefore, does not draw these supplies. The latter train has then a surplus, and when it is subsequently refilled at the railhead, it leaves undrawn at that point a corresponding quantity. Similarly, the railroad train has a surplus, which it carries back to the regulating station, where the general readjustment is made.

In addition to the ration, commanders of organizations and detachments are given a daily allowance of twenty centimes (four cents) per day per man, with which they are authorized to purchase locally additional food supplies. This fund corresponds to the United States army company fund.

In times of peace, in garrison, the French ration is largely commuted at prices fixed by corps commanders and based on the local market prices. In time of war this system is not used except in the case of very small detachments (principally cavalry), chauffeurs, and other individuals who cannot be conveniently rationed by organizations. In the latter case the commutation rate is fixed in army orders. In the positions occupied by the French army during 1917 it has been comparatively easy to supply the men and animals, the utmost advantage having been taken of the elasticity allowed for substitutions and additions to the ration.

The entire French army in the zone of the armies had a most trying time during the winter, due to cold and the water in the trenches. Roughly speaking, from one-third to one-half of the time they have been in the first-line trenches, the remainder of the time they have spent

either in supporting trenches or in towns more or less subjected to German artillery fire. In the first-line trenches the quarters or dugout shelters of the men are heated with coke or charcoal fires, which give out no smoke. Food is cooked in large kettles and field kitchens behind the trenches and is subsequently taken out to the front-line trenches and distributed. The men eat a hot, cooked meal at night and save the rest of the food for the next day's lunch, when it is heated before eating over the fires in the dugout shelters. Men and officers say they have all fared better under these trying conditions than they usually fare in barracks in peace time. The result of this good feeding is apparent in the physical condition of the men and in the astonishingly low sick reports. The Government and the army commanders have realized the importance of keeping the men fit during all this period of more or less enforced stationary siege fighting. They have thoroughly realized that it is very poor economy to restrict the food when there is no necessity for it, as there may be later on if a forward movement is undertaken in a country with all the railroads destroyed.

The *reserve* ration is the ration that is carried on the man or horse. Within the last few years an effort has been made to reduce the load carried by the man, and a portion of this reserve ration is now carried in the combat train. The reserve ration carried by divisional cavalry, and that carried by all elements of a cavalry division, is one day's hard bread, three days' coffee and sugar, and one day's canned meat and *potage salé*. The total gross weight of these components of the reserve ration is 2.53 pounds. In addition, one day's brandy per man is carried. The reserve ration carried by all other troops and elements of the army is a straight two days' ration, except that only one day's brandy is included. One-half of this reserve ration is carried on the man, the other half plus the brandy is carried on the baggage wagon attached to the combat train.

The reserve ration is, in general, only consumed when so ordered by corps or division commanders, when contact cannot be made with the ration wagons. In rare cases, where there are no other means of feeding the men, organization commanders may, on their own responsibility, authorize its consumption. In this latter case a full written explanation of the reason must be submitted.

The *normal* ration is that prescribed for troops in time of peace in barracks, or in time of war when comfortably quartered, out of the presence of the enemy.

The *strong* ration is that usually supplied daily in the field to French troops, and it is on the weight of this ration that transportation allowances

are based. It is realized by the French that troops in the field are subjected to much more severe physical effort than troops in garrison. To provide this additional energy, additional food is given in the shape of a strong or increased ration. As already explained, the strong ration is very elastic and supple. Almost any condition can be met without the fear of violating regulations.

In principle the French soldier (not including the cavalryman) receives each night from the ration wagon the supplies that he is to consume at his two meals the following day. It will be remembered that, with the exception of coffee early in the morning, Frenchmen only eat two meals per day, one before noon and one in the late afternoon. These supplies he carries in a light canvas bag (*musette*), swung with a loop on his right shoulder. At the same time he receives one day's ration of fresh meat, which is issued him from the *voiture de viande* (meat wagon), which is attached to the combat train. One-half of this is eaten the night on which it is issued and one-half, after cooking, is put in the *musette* to be eaten cold the next noon. We thus find that every morning, upon leaving camp or bivouac, the French soldier has with him (independently of the reserve ration) one day's supply of field bread, one-half day's supply of fresh meat (cooked), one day's supply of dried vegetables to be cooked for the evening meal, one day's supply of salt, and one day's coffee and sugar, with the exception that some of this coffee and sugar is used in the morning. As before explained, these supplies may be varied by substitutions and additional purchases made from the four cents allowed to each man over and above the ration.

In the cavalry every effort is made to reduce the weight carried by the horse, and, in consequence, rations are issued theoretically, every evening before supper. The evening meal and a cooked cold luncheon for the next day are prepared for the same evening. We therefore find that in the morning, upon leaving camp, the cavalry has, in addition to its reserve ration, only the food necessary for one meal. Under this system it may be readily seen that the evening meal of the regular rations (the strong ration) is dependent upon the ration wagons making contact with the troops in time for the preparation of the meal. It will, of course, be remembered that so long as the cavalry is inactive it will probably be kept near a place where rations can be readily supplied, and if active, it will be in a better position than other troops to secure its supply locally. This system of issuing rations is called by the French *"au cheval."* Previously it had been used with all troops, and it is still used by such of the

French organizations as are equipped with rolling kitchens. However, with infantry troops not equipped with rolling kitchens, it has been found not to be practicable, owing to the delay of the ration wagons in making contact with the troops.

TRAINS.—Each organization, including division and corps headquarters, has a combat and a regimental train (field train). To the corps are also attached a corps supply train and a corps meat train (auto trucks). In addition, there is a corps cattle park.

The combat train is divided into two *echelons,* called the first and second, respectively. For purposes of clearness, the combat train of an infantry regiment, as laid down in the French regulations, will be explained. The same principles apply to the other combat trains, though they differ considerably in details in the different armies. The strength of an infantry regiment is 3,000 men, and this strength is maintained by reserves sent forward to replace all losses.

The *first echelon* remains with or in the immediate rear of the organization to which it belongs when on the march or during combat. It includes one-horse sanitary carts carrying equipment for first-aid stations, two-horse carts for ammunition for companies, four-horse wagons or caissons for machine-gun ammunition, and two-horse carts carrying entrenching and other tools.

The *second echelon,* while on the march out of the presence of the enemy, usually accompanies the first echelon. When contact with the enemy is expected, it is detached and grouped with other second echelon combat trains, either in brigade or division groups, depending upon the orders issued. During this period of grouping, its movements are controlled by the headquarters ordering the grouping. The grouped second echelons are usually held well in the rear under cover and "out of the road." This echelon includes two-horse wagons (on these wagons are also carried a portion of the reserve rations previously referred to), a two-horse forage wagon, and three two-horse meat wagons (one per battalion). In addition, the regulations provide that the two-horse rolling kitchen (when organizations are equipped with the same) will form part of the second echelon of the combat train.

The regimental train (*train régimentaire*) corresponds exactly to the ration section of the field train of the United States army. All field units, including the different headquarters and trains, with the exception of the corps supply train, have a regimental train. The regimental trains

of all units, except that of the cavalry division, carry the following supplies (on the basis of the strong ration):

Bread (generally field bread)	2 days
Salt	2 "
Lard	2 "
Rice or dried vegetables (1 day of each)	2 "
Canned meat with *potage salé*	1 day
Coffee (1 day's supply is on the basis of the reserve ration)	2 days
Sugar (1 day's supply is on the basis of the reserve ration)	2 "
Brandy	1 day
Oats	2 days

The regimental trains of the cavalry divisions carry the following supplies (on the basis of the strong ration):

Field bread	1 day
Salt	1 "
Canned meat with *potage salé*	1 "
Coffee (on the basis of the reserve ration)	1 "
Sugar (on the basis of the reserve ration)	1 "
Brandy	1 "
Oats	1 "

The foregoing figures are based on the load at the time the troops start out, which, of course, changes as soon as issues begin. It is not safe, therefore, to count on having on hand more than one day's supply.

The regimental trains of all units are usually kept grouped at all times when the troops are on field service. This grouping is almost invariably by divisions, the group being under the orders of a single officer, who moves the grouped trains in accordance with orders received from division headquarters. When the troops have halted, orders are issued from division headquarters to send forward one day's supply of food, and men from the different organizations go to the grouped trains and conduct the loaded vehicles to the troops. The issues are made, and the empty vehicles are at once sent back and grouped again. If any supplies are obtainable locally, and their substitution is desired by the troops in place of what is carried in the wagons, the substitution is made, and the corresponding ration articles remain unissued in the wagon.

From time to time the division headquarters is notified of the point selected as the "distributing point," and it in turn notifies the officer in command of the grouped train, who sends the empty wagons to that point at the hour fixed for reloading. As soon as they are reloaded they rejoin the grouped train.

MEAT SUPPLY.—The system of fresh-meat supply in the French army has been materially changed in recent years. Formerly each division had a cattle park, where the cattle were butchered and from which the dressed meat was sent forward in wagons, their loads being transferred to the meat wagons of the second echelon of the combat train. This was found to be very cumbersome. To-day the division cattle park has been suppressed and replaced by the corps cattle park, where the slaughtering is now done. The fresh meat is loaded in the army corps meat train, which is pushed forward close to the point where the grouped second echelon of the combat train is halted, and the organization meat wagons are filled at these places.

The meat supply of the French soldier has always been a most difficult question, because of the national prejudice in France against refrigerated meat. This prejudice is somewhat on the wane to-day, owing to a lack of cattle in France, and a great quantity of Argentine beef is now being received. There is some trouble in handling this beef, due to the fact that refrigerator railroad cars are hardly known in France, and to the further fact that there are not many cold-storage plants for the reception of the meat. Of course, most of the big cities have these plants, but none are found in the small towns as in America. To-day an effort is being made to use the refrigerated meat in the zone of the interior and as far as possible to reserve the live cattle for use in the zone of the armies. The Frenchman does not like our cured bacon nor does he like canned meats. His wants, therefore, so far as meat is concerned, are much more difficult to satisfy than is the case with our troops.

With a view to the simplification of the entire fresh-meat supply, a number of different methods have been and are being tried in France. One method by which the fresh meat was thoroughly salted (*viande demi-salé*) was tried out, but has been practically abandoned to-day. This system had the advantage that the meat could be slaughtered and treated well to the rear, even back of the zone of the interior, and could be sent forward in the regular trains through the regulating station. If successful, it would have done away with the corps cattle park and the corps meat train. The disadvantage was due to the fact that, while the center of the meat so treated was perfectly good, the exterior surface became discolored and somewhat decayed and smelly.

To-day a new scheme is being tried by which the fresh meat is first cooked and boned, then wrapped in cheesecloth, and the moisture pressed out. If this is successful, it will greatly simplify the problem of meat supply, particularly if the war lasts long, and if refrigerated beef has to

be resorted to entirely. If, after cooking and treatment in the manner indicated, meat will keep for five or six days, the plan will be successful.

The autotruck made it possible for the French to do away with the division cattle park and to do their slaughtering at the corps cattle park, well in the rear. All the autobuses in Paris were requisitioned for delivery purposes, and these are to-day distributed between the different army corps, forming the corps meat trains. These autobuses have somewhat the appearance of one of our street cars in America, having a platform on the rear and windows on either side. The glass in the windows has been removed and replaced by fly screens with cotton bunting behind to keep out the dust. The meat is suspended from hooks placed on the rods running along the ceiling of the car, which previously furnished the supports for the hand straps. Each autobus will carry approximately 4,000 pounds of beef. Approximately fifteen of these autobuses are assigned to each corps. The maximum distance to the front which they are able to supply is seventy-five kilometers. It, therefore, follows that the corps cattle park can be no further than this to the rear.

Corps cattle parks are usually situated near the railroad, where cattle on the hoof are delivered by train. Their equipment is the simplest possible, notwithstanding the fact that the daily requirements of a corps necessitate the slaughter of from 100 to 120 head of cattle a day. Usually barns and stables are used for this purpose. The equipment in general consists of large wooden tripods or derricks, about eight feet high. After the animal has been hit on the head, he is pulled up by the hind legs, the throat arteries are cut, and the meat is dressed. The hides are all most carefully saved and shipped back to the rear. The meat when cut up is at once loaded into the autobus, where it cools. A veterinary surgeon is always present during the slaughtering to pass on the quality of the meat.

Slaughtering is usually done in the late afternoon, the autobuses or corps meat train being sent forward the following morning to make contact with the organization meat wagons (attached to the second echelon of the combat train). The meat is then transferred, and the autobuses return to receive their new loads during the slaughtering in the afternoon. Effort is always made to counteract, so far as possible, the slowness in movement of beef on the hoof (about four kilometers an hour). As has been shown, the park with the meat train can be operated seventy-five kilometers behind the troops. This is about three days' march under the most favorable conditions for the troops. When a rapid advance is undertaken a portion of the personnel of the cattle park is sent forward to a point farther advanced, and cattle are shipped in and held in anticipation

of the arrival of the remainder of the personnel. When all the cattle have been slaughtered at the first place, the tools and equipment are loaded in an autotruck and sent forward to the new position. Thus, within a few hours the park can be advanced, if necessary, three days' march. The corps meat train is the only corps train to which autotrucks are regularly assigned. The autotruck in this case is a "transportation unit" pure and simple and does not provide the means for transporting a "rolling reserve." The rolling reserve of meat is carried in the corps supply train.

The corps supply train carries two days' strong ration and two days' oats. The load consists of the following supplies:

Salt	2 days
Dried vegetables	1 day
Rice	1 "
Sugar (1 day's strong and 1 day's reserve ration)	2 days
Coffee (1 day's strong and 1 day's reserve ration)	2 "

FIGURES UPON WHICH ALLOWANCES OF TRANSPORTATION FOR RATIONS ARE BASED

The net weight of the reserve ration, not including brandy, is 1.6852 pounds.

The net weight of the strong ration, with field bread, canned meat, potage salé, and not including spirits, is 2.6972 pounds.

The net weight of the strong ration without meat and spirits, and including lard, is 1.9932 pounds.

Great Britain.—"The ration of the British soldier, *in garrison,* consists of 16 ounces of bread, 12 ounces of meat, and such additional articles (vegetables, groceries) as are purchased out of a daily allowance of seven cents. During maneuvers the meat is increased to 16 ounces.

"*In the field,* his ration varies according to climate and the character of his work; it generally consists of 16 ounces of salted or preserved meat, or 16 to 20 ounces of fresh meat; 20 ounces of fresh bread or 16 ounces of hard bread or flour; 1 ounce of compressed vegetables, or 8 ounces of potatoes (or other fresh vegetables), or 2 ounces of rice (or split peas), or 4 ounces of onions; coffee, tea or chocolate, sugar and the usual condiments. Two ounces of spirits and some tobacco may also be allowed" (4).

An *emergency ration* is provided in the British army, for use only when no other food is procurable and when authorized by the commanding officer. It is contained in a flat can and consists of chocolate, sugar and protein in the form of "plasmon," weighing 6½ ounces net. According to Langworthy, its proximate principles average: protein 59 grams, fat 50 grams, and carbohydrates 65 grams, with fuel value of 973 cal-

ories. This ration, like the United States emergency ration, is relatively too rich in protein and deficient in carbohydrates.

According to the "Times History of the War," the ration of the English soldier at the beginning of the present war was:

1¼ pounds biscuit
1 pound fresh meat or 1 pound tinned meat
4 ounces jam
3 ounces sugar
3 ounces desiccated vegetables
⅛ ounce tea
½ ounce coffee
⅛ ounce pepper
⅛ ounce salt

At the outbreak of the war, the ration was increased by an addition of good bacon, 4 ounces, and cheese, 3 ounces; six months later, the meat ration was increased to 1¼ pounds of fresh meat and a more liberal allowance of tea was permitted; occasionally, ⅛ of a tin of condensed milk is given in place of the extra ¼ pound of meat.

Systems of Supply.—In France, the bread and a trifle of sugar and coffee are supplied in kind, the rest being supplied by the war department, and gardens are an essential part of the scheme. In Italy the food is supplied on the same basis as the clothing allowance in the United States army—that is, so much money per day is allotted to each soldier, and if he is supplied in kind, so much money is deducted from his account. In Austria only, bread is supplied in times of peace, and a daily allowance of money given to purchase the rest, somewhat as in France. In Russia, bread and meat are supplied in kind, but a money allowance is given for other things and for extra meat. In Spain, bread only is supplied, as in Germany, and the rest is charged up against the soldier's pay, as in England. These systems are all very well in countries where the soldiers live in thickly settled districts, where they have opportunities to buy such things as they want, but would be totally unsuitable for the frontier in our country; hence, the United States is the only nation compelled to supply the soldier's whole food.

At the commencement of the United States Civil War the supplies to be carried by the troops were prescribed in General Orders, which provided that in ordinary marches, where the men could receive daily issues from the trains, they should carry only two days' rations; but in the immediate vicinity of the enemy, and where the exigencies of the service rendered it necessary to move without baggage or trains, they were required to carry from eight to twelve days' rations. In the Spanish-

American War, the General Orders did not prescribe the number of days' rations to be carried by the men.

In the German army, foot troops, horse and field artillery, and train, carry three days' "iron" rations, the cavalry one day's. The German "iron ration" consists of hard bread, 9 ounces; preserved meat or bacon, 7 ounces; vegetables, 3½ ounces; coffee, ⅞ ounce. Total weight, including packing, 1 pound, 10 ounces; three days' rations, 4 pounds, 14 ounces.

In the French army the cavalry carry one day's bread, preserved meat and groceries, and all other troops two days'. This ration consists of bread, about 33 ounces; preserved meat, about 9 ounces; groceries, about 5½ ounces. Total weight, 47½ ounces, or about 3 pounds.

In the Russian army the infantry carry 2½ days' hard bread in their haversack; the cavalry and horse artillery, 1½ days'; field artillery and sappers, 3 days'. The hard bread ration consists of 1 pound 13 ounces; 2½ days', therefore, would be about 4½ pounds.

The United States Field Service Regulations provide for the minimum to be carried on the man or horse—1 emergency ration and 1 field ration. Weight: 1 field ration, 2.92 pounds net, 3.64 pounds gross; 1 emergency ration, 1 pound net, 1.25 pounds gross; total, 4.89 pounds gross, or nearly 5 pounds.

COMPARATIVE RATIONS OF THE ARMIES OF THE WORLD

Below are given the rations of the soldiers of the leading armies of the world, both in times of peace and war. According to Colonel Woodruff, when these are compared with the ration of the soldier in the United States army, it will be seen that our men are better fed than men in any other army of the world:

COMPARATIVE RATIONS OF THE LEADING ARMIES OF THE WORLD

DAILY RATION OF THE AUSTRIAN SOLDIER

Peace	Ounces	War	Ounces
Meat	6¾	Meat	9¾
Bread	30¾	Or salt meat or bacon	6
Or biscuit	17¾	Biscuit	3½
Flour	6¾	Flour	26¼
Or groats or barley	6½	Vegetables	5
Or potatoes	20	Potatoes	9
Rice	3¾	Peas or beans	5¼
Sauerkraut	5½	Or potatoes	....
Butter or fat	¾	Butter or fat	1⅜
		Sugar	¾
		Coffee	¾

COMPARATIVE RATIONS OF THE LEADING ARMIES OF THE WORLD—*Continued*

DAILY RATION OF THE ENGLISH SOLDIER

Peace	Ounces	War	Ounces
Meat, fish, bacon, or liver	12	Meat, fresh	16 or 20
Bread	16	Or preserved	20
Vegetables	4	Bread	20
Potatoes	12	Or biscuits	16
Milk	5	Vegetables, fresh	16
Sugar	2	Or compressed	1
Butter	1	Peas or beans in lieu of vegetables	3
Peas or beans, in lieu of vegetables	1½	Sugar	3
Lime-juice	1	Cheese	2 to 3
Salt, ½; tea, ⅙ or coffee	½	Tea, ½; coffee or cocoa	½
		Pickles, occasionally	
		Rum, when necessary	2½

DAILY RATION OF THE FRENCH SOLDIER

Peace	Ounces	War	Ounces
Meat	10½	Meat	14½
Bread	26¼	Bread	26¼
Or biscuits	21	Or biscuits	21
Vegetables, fresh	3½	Vegetables, compressed	1
Butter	2⅛	Butter	1
Other articles are paid for by men out of their allowance. Laveran estimates that the ordinary peace ration contains 124 grams protein and 764 grams carbohydrate.		Rice	2¼
		Sugar	¾
		Soup, condensed	¼

DAILY RATION OF THE GERMAN SOLDIER

Peace	Garrison Ounces	Field Ounces	War	Ounces
Meat	5½	17½	Meat	13¼
Or bacon	4½	6	Or sausage	8¾
Bread	26½	35½	Bread	26½
Or potatoes[1]	53	71	Or potatoes	52
Oatmeal	4¼	6½	Vegetables	6
Rice	3⅙	....	Rice or ground barley	4½
Coffee	....	1½	Coffee	1
Butter	....	1¾	Brandy	3½
			Or wine	17½
			Or beer	35

[1] In lieu of potatoes, 12 ounces of peas or beans.

COMPARATIVE RATIONS OF THE LEADING ARMIES OF THE WORLD—*Continued*

ITALIAN RATION

Peace	Ounces	War	
Meat	7 to 11		
Bread, flour, or biscuit	32½		
Bacon	9½		
Rice	5¼		
Sugar	¾		
Coffee	½		
Wine[1]	8¾		

RATION OF THE JAPANESE SOLDIER

Peace	Ounces	War	Ounces
Rice	36	Meat (periodically)	16
Money allowed for other necessaries.		Fresh fruit	20
		Rice (daily)	36
		Vegetables	4
		Bean sauce	2
		Pickles or fruit	2
		Sugar	½
		Tea	¼
		Japanese cake	8
		Sake (spirit)	6½
		Cigarettes	20

DAILY RATION OF THE RUSSIAN SOLDIER

Peace	Ounces	War	Ounces
Meat	7¼	Meat	7¼
Flour or biscuit	26	Or ham	3½
Groats	4	Flour	29
Or peas or beans	14½	Sugar	¼
Or potatoes	27¼	Tea	¼
Or turnips or carrots	35	Butter	¾
Or cabbage	50	Peas or beans	5
		Groats	4¾
		Variable as in peace ration.	

[1] *See* footnote, page 683. We do not think it wise to allow whiskey, beer, wine or brandy as a component of the soldier's ration. Certainly no man having indulged in alcoholic drinks should be permitted to engage in the work of aviation, nor allowed to participate in the handling of large and expensive guns. There has been a great revolution of sentiment regarding the use of alcohol since the beginning of the Great European War.

DIET IN PRISON CAMPS

Dr. B. W. Caldwell, of the American Red Cross,[1] after an investigation of European prison camps, in writing on the subject in *The Military Surgeon*(12), says that the only emergency not carefully thought out and for which every detail of preparation was not arranged by the General Staffs of the belligerent armies was the treatment of the prisoner of war. After describing the conditions of the prisoners and the prison camps and the precautions taken to put both in a sanitary condition, he describes the kitchens attached to the camps as well constructed and well equipped and in excellent condition of cleanliness. He observed that the food furnished the prisoners was limited in variety and insufficient in quantity and largely vegetable in character, consisting of potatoes, carrots, cabbage, turnips, beans, peas, lentils and other dehydrated vegetables; of meals made from corn, soy beans and peas, of dried fruits and salt fish and small rations of meat. Each prisoner was allowed coffee, and 300 grams of bread per day. The unprepared food was found to be of very good quality, containing nothing deleterious. Necessity has always been the mother of invention, and as the prisoners were without knives and forks, it became necessary to prepare the ration in such a manner that it could be served in large bowls and eaten with spoons. The Germans solved this problem by cooking the different articles of the ration together, in large cylindrical cookers, heated with coal, the cooking process being continued until the whole mass was soft and in a condition to be eaten with a spoon. It was well seasoned and fairly palatable, but did not afford the variety in preparation or ingredients, nor was the quantity sufficient, for a well-balanced diet, as will be seen by examining the following actual dietaries at different prison camps:

TRANSLATION FROM ORIGINAL MENU OF THE PRISONERS' KITCHEN AT CAMP MÜNSTER

(*November 22d to 28th, 1915*)

MONDAY

Breakfast: Corn mush, 100 grams; evaporated milk, 10 grams; sugar, 10 grams; bread, 100 grams.

Dinner: Beans, 200 grams; potatoes, 600 grams; lard, 10 grams; bread, 100 grams.

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[1] Dr. Caldwell, at the request of the Ambassador of the United States at Berlin, with the official approval of the German Government, made a thorough inspection of the Prison Camps at Münster, Wittenberg, Altdam and Güterslohe during the month of November, 1915. He was at that time Director of the Red Cross Sanitary Mission to these Prison Camps. The facts here so clearly and dispassionately set forth are thus at once authentic and official.

Supper: Potatoes, 400 grams; Swedish turnips, 400 grams; lard, 5 grams; bread, 100 grams.

TUESDAY

Breakfast: Coffee as on Sunday; bread, 100 grams.

Dinner: Carrots, 500 grams; potatoes, 600 grams; beef, 120 grams; bread, 100 grams.

Supper: Potatoes, 400 grams; chestnuts, 150 grams; sugar, 10 grams; bread, 100 grams.

WEDNESDAY

Breakfast: Barley, 50 grams; meal of rolled potatoes, 50 grams; lard, 5 grams; bread, 100 grams.

Dinner: Swedish turnips, 500 grams; potatoes, 500 grams; corned beef, 100 grams; lard, 5 grams; bread, 100 grams.

Supper: Potatoes, 400 grams; sausage, 100 grams; sauerkraut, 300 grams; bread, 100 grams.

THURSDAY

Breakfast: Coffee as on Sunday; bread, 100 grams.

Dinner: Codfish, 200 grams; cabbage, 400 grams; potatoes, 600 grams; potato meal, 10 grams; oleomargarine, 10 grams; onions, 10 grams; spices as needed; bread, 100 grams.

Supper: Potatoes, 400 grams; carrots, 500 grams; bread, 100 grams.

FRIDAY

Breakfast: Rolled potato meal, 100 grams; evaporated milk, 10 grams; bread, 100 grams.

Dinner: Flour, soy bean, 120 grams; potatoes, 600 grams; onions, 10 grams; lard, 10 grams; bread, 100 grams.

Supper: Potato salad and potatoes, 500 grams; oil of soy bean, 500 grams; vinegar, according to need; one herring; bread, 100 grams.

SATURDAY

Breakfast: Coffee as on Sunday; bread, 100 grams.

Dinner: Dried peas, 150 grams; potatoes, 600 grams; bacon, 30 grams; bread, 100 grams.

Supper: Potatoes, 400 grams; dried vegetable, 30 grams; lard, 5 grams; bread, 100 grams.

SUNDAY

Breakfast: Coffee, 5 grams; coffee substitute (Zusatz), 3 grams; sugar, 30 grams; bread, 100 grams.

Dinner: Potatoes, 600 grams; cabbage, 500 grams; Cassel spare ribs, 100 grams; lard, 5 grams; bread, 100 grams.

Supper: Potatoes, 400 grams; cheese, 80 grams; bread, 100 grams.

MENU OF THE WAR PRISONERS' KITCHEN, OFFICERS' SECTION AT GÜTERSLOHE

(*November 22d to 28th, 1915*)

MONDAY

Breakfast: Coffee, 20 grams; coffee substitute (Zusatz), 10 grams; milk, 60 grams; bread, 100 grams; marmalade, 50 grams.

Dinner: Barley (soup), 150 grams; potatoes, 750 grams; beef (boiled), 125 grams; bread, 100 grams; lard and flour each, 20 grams.

Supper: Oat-flake porridge with prunes, 500 grams; tea, 5 grams; sugar, 25 grams; bread, 100 grams.

TUESDAY

Breakfast: Same as Monday.

Dinner: Carrots, 150 grams; potatoes, 750 grams; pork (roast), 110 grams; bread, 100 grams; lard and flour each, 20 grams.

Supper: Liver sausage, 90 grams; tea, 5 grams; sugar, 25 grams; bread, 100 grams.

WEDNESDAY

Breakfast: Same as Monday.

Dinner: Swedish turnips, 150 grams; potatoes, 750 grams; veal (roast), 125 grams; bread, 100 grams; lard and flour each, 20 grams.

Supper: Porridge with milk, 500 grams; tea, 5 grams; sugar, 25 grams; bread, 100 grams.

THURSDAY

Breakfast: Same as Monday.

Dinner: Cabbage, 150 grams; potatoes, 750 grams; mutton, 125 grams; bread, 100 grams; lard and flour each, 20 grams.

Supper: Salt herring with boiled potatoes in jackets, 500 grams; tea, 5 grams; sugar, 25 grams; bread, 100 grams.

FRIDAY

Breakfast: Same as Monday.

Dinner: Meat, 125 grams; potatoes, 750 grams; mustard gravy, 100 grams; bread, 100 grams; mustard, 10 grams; lard and flour each, 20 grams.

Supper: Liver sausage, 90 grams; tea, 5 grams; sugar, 25 grams; bread, 100 grams.

SATURDAY

Breakfast: Same as Monday.

Dinner: Red cabbage, 150 grams; potatoes, 750 grams; bologna sausage, 125 grams; bread, 100 grams; lard and flour each, 20 grams.

Supper: Pea soup with boiled pig's ears, 500 grams; tea, 5 grams; sugar, 25 grams; bread, 100 grams.

SUNDAY

Breakfast: Same as Monday.

Dinner: Roast of veal, 125 grams; potatoes, 750 grams; compote, 100 grams; bread, 100 grams; lard and flour each, 20 grams.

Supper: Holland cheese, 90 grams; tea, 5 grams; sugar, 25 grams; bread, 100 grams.

Alonzo E. Taylor, M.D., writing in the *Journal of the American Medical Association,* Nov. 10, 1917, on the "Diet of Prisoners of War in Germany," says that early in the war prisoners subsisted on rations furnished on contracts. The contract system was later abandoned and the German government regimen was issued in the spring of 1915. The ration pro-

vided German prisoners contained protein, 85 grams; fats, 40 grams; and carbohydrates, 475 grams; with a total fuel value of 2,700 calories. In June, 1916, the ration was as follows: protein, 89 grams; fat, 30 grams; and carbohydrates, 510 grams; with a total fuel value of 2,700 calories.

WEEKLY DIET SHEET TYPICAL OF PERIOD PRIOR TO STRINGENCY IN FOODSTUFFS[1]

	Gm.	Ounces.		Gm.	Ounces.
Bread	2,100	75	Sugar	200	7.1
Flour	270	9.6	Legumes	150	5.3
Meat	300	10.7	Fat	70	2.5
Fish	300	10.7	Maise grease	180	6.4
Herring	150	5.3	Pearl barley	100	3.5
Potatoes	9,000	321	Dried fruit	50	1.8
Vegetables	1,800	65	Marmalade	100	3.5
Skim milk	400	14	Tea	16	0.5
Sausage	200	7	Spices, herbs	30	11.1
Cheese	100	3.5	Cocoa	40	1.4
Nutrient yeast	40	1.4			

[1] Per diem: protein, 89 gm.; fat, 30 gm.; carbohydrate, 510 gm.; calories, 2,740.

WEEKLY DIET SHEET TYPICAL OF PERIOD OF STRINGENCY IN FOODSTUFFS[2]

	Gm.	Ounces.		Gm.	Ounces.
Bread	2,100	75	Legumes	150	5.3
Flour	50	1.7	Fat	65	2.3
Meat	200	7	Maise grease	100	3.5
Sausage	200	7	Pearl barley	60	2.1
Fish	325	11	Fruit	300	10.7
Potatoes	3,500	125	Marmalade	100	3.5
Vegetables	1,650	59	Tea	4	0.15
Skim milk	500	17	Coffee	6	0.21
Cheese	100	3.5	Chicory	15	0.5
Nutrient yeast	20	0.7	Cocoa	40	1.5
Sugar	130	4.8	Spices and herbs	20	0.7
Mustard	50	1.7			

[2] Per diem: protein, 57 gm.; fat, 21 gm.; carbohydrate, 310 gm.; calories, 1,720.

The above two diet sheets, says Taylor, serve to illustrate the subsistence in the German prisoner of war camps. The first is typical of the beginning of food stringency, and the second serves as a contrast of the

present deplorable shortage of foodstuffs. Taylor points out from these figures the necessity of our government taking cognizance of the food conditions in Germany, and suggests that steps be taken to organize ways and means to feed Americans who may be taken prisoners of war by Germany.

CONCLUSIONS REGARDING THE COMPOSITION AND FOOD VALUE OF THE MILITARY RATION (HARVARD)(4)

"We have previously stated, on good grounds, that an adult man weighing 154 pounds is in better physical condition, stronger, and capable of greater endurance, with a ration yielding 2,800 calories, especially if the proteins are kept within a maximum of 60 grams, than with one greatly exceeding this value. But we have seen that in our service, as in all other leading countries, the soldier's ration exceeds these limits in the number of calories, which range from 3,000 to 5,000, but especially in the amount of proteins (Japanese excepted), which hardly ever fall below 100 and often range up to 160 or more grams. There is no indication, therefore, that in this country or in Europe the soldier is underfed, provided he actually receives the ration called for by military regulations.

"Much has been written on the necessity of feeding the soldier well and much attention and study have been devoted to the composition of adequate rations. That he should be sufficiently and properly fed, needs no discussion, but the belief generally entertained that the more he eats the greater is his energy and efficiency is groundless and mischievous. The danger of overeating has been too much overlooked, or else esteemed a negligible factor. It is the opinion of many careful observers that the American soldier is much more likely to be overfed than underfed, and that his health and efficiency stand in greater peril from excess than from lack of food. As a general rule, the soldier does not know how to regulate his appetite, nor does he appreciate the necessity of doing so. He eats what is allowed him hurriedly and often without proper mastication, and between meals frequently patronizes the lunch counter of the post exchange or the outside shop where pies and other tempting pastry are displayed. This is characteristic of the soldiers of all countries, particularly of those who receive the most liberal rations. Thus, the remarks of Rouget and Dopter, in their 'Hygiene Militaire,' although aimed at their countrymen, are of very general application. 'Many Frenchmen, especially in the country, have the pernicious habit not to cease eating until

they experience a sensation of fullness in the stomach. Little do they care about the nutritive value of the food ingested. Their conviction is that, so long as this abdominal repletion is not distinctly felt, they have not been sufficiently fed. This is particularly observed each year at the time of the incorporation of the new contingent. The amount of bread in the ration, although considerable, is not enough to satiate these young soldiers; they buy more from outside bakeries.'

"It should be remembered that within an hour or two after taking a full meal, at least a pint of gastric juice is poured into the stomach and added to its contents, so that what was at first mere repletion may become uncomfortable distention. Soldiers should be advised that a sensation of fullness or distention following a meal is a clear admonition that they have eaten too much, and that if such excess is kept up, as a habit, they will surely suffer in health and efficiency. Such advice may do good, but more practical results will follow if the food, especially the meat, as served in the mess-room, is simply sufficient and not wastefully abundant.

"Experience shows that it is while actively engaged in the field, when the rations are reduced and the cooking simple, that the men enjoy the best health and show most endurance, provided, of course, there is no actual lack of food. Thus, during the active part of the Santiago campaign in 1898, there was but little sickness in spite of the trying climate and of short commissary supplies, but as soon as the work was over and rations became abundant, the morbidity began to rise and before long exceeded seventy-five per cent of the command. It is hard to resist the conviction that injudicious feeding was responsible for many of the cases of 'undetermined fever,' and prepared the way for much of the malaria which prevailed in our camps near Santiago, as well as of the typhoid fever which decimated our troops in the United States. It is noteworthy that the Spanish soldiers in Santiago, although reduced to very scant rations of poor quality, had a much smaller proportion of sick than the American troops.

"During the Boer War in South Africa, the English troops besieged in Ladysmith were fed for several months, according to Dunlop, on a ration of 73 grams of protein, 69 of fat, and 141 of carbohydrates, with fuel value of only 1,527 calories, but which, as remarked by Munson, furnished energy enough for a stout and successful resistance. The Russo-Japanese War has taught us an important lesson in dietetics. Both Russians and Japanese had meat rations much smaller than those provided for American, English and French soldiers; the meat ration of the

Japanese, in particular, was decidedly meager and often lacking altogether. Yet we know that no armies, during an arduous war of twenty months, ever suffered so little from infectious diseases and had fewer men incapacitated from sickness. To what extent this immunity is due to the food can only be conjectured. It certainly cannot be attributed exclusively to the sanitary measures taken, for it was the opinion of the American and English *attachés* with both armies, that had their own troops been placed under similar conditions, but fed with their own rations, typhoid fever would undoubtedly have prevailed among them in an epidemic form.[1] It is true that the Japanese suffered much from beriberi during this war, a disease known to be due to an excess of rice combined with a deficiency of protein, but there is no doubt that it would have been entirely prevented had the Japanese soldier received one-half of the protein component called for by the ration of the United States soldier.

"Surgeon Tsui of the Chinese army(13) states that, in Northern China, the country laborers from whom the army is mostly recruited, men of fine physique and most remarkable power of endurance, live almost exclusively on a vegetable diet. The Chinese soldier receives meat only twice a month. The rates of sickness and death in the Chinese army, according to this trustworthy authority, are much lower than in our army.

"Formerly, the price of savings made from the ration and paid by the Quartermaster Corps to the organization commander, could be expended by the latter in any way deemed most advantageous to the organization, that is, not only in the purchase of other kinds of food, but of any articles intended for the comfort and enjoyment of the men, such as games, sporting goods, etc. Under existing regulations, money received as balance of the 'ration and savings account' can be spent only for food. It follows that the company commander has no longer any discretion in regulating the amount of food consumed by his men, but is expected to expend the entire money value of the ration in the purchase of foodstuffs." Colonel Harvard(4) cannot commend this change. He believes that the former system, whereby the company commander was allowed discretion in regulating the quantity as well as the quality of the food, was better calculated to safeguard the health and comfort of his men.

NAVY RATIONS

During recent years much attention has been given to the selection and preparation of the ration for the United States sailor. In former days,

[1] I question this statement.—G. N. K.

it was a notorious fact that the character of the food on board ship was monotonous, uninviting and led to nutritional disorders. In the present navy ration, according to the Revised Statutes, [1] the following allowances of provision constitute the daily ration:

1 pound hard bread (biscuits); or 1¼ pounds fresh bread; or 1⅛ pounds flour
1 pound tinned meat; or 1¼ pounds of salt meat; or 1¼ pounds smoked meat; or 1¾ pounds fresh meat; or 1¾ pounds fresh fish; or 8 eggs; or 1¾ pounds poultry
¾ pound tinned vegetables; or 1¾ pounds fresh vegetables; or 3 gills beans or peas; or ½ pound rice or other cereal
2 ounces coffee; or 2 ounces cocoa; or ½ ounce tea
1 ounce evaporated milk; or 1/16 quart fresh milk
3/16 pound dried fruit; or ⅜ pound tinned fruit; or 3/16 pound fresh fruit (one ration of fruit is allowed with each ration of beans, peas, rice and other starch foods and canned vegetables issued)
2 ounces butter
4 ounces sugar
7 ounces lard for every 100 pounds flour used as bread

The weekly ration consists in addition of the following:

¼ pound cheese	¼ pound salt
¼ " macaroni	¼ pint sirup
1/32 " pepper	1/128 pound spices
¼ " pickles	¼ pound tomatoes (canned)
1/32 " mustard	½ pint vinegar or oil

Yeast, baking powder and flavoring extracts as required

In addition to the foregoing, the following issues are allowed to men of the engineer and dynamo force standing watch under steam between the hours of 8 P.M. and 8 A.M.

4 ounces hard bread or its equivalent
1 ounce coffee
4 ounces tinned meat or its equivalent
2 " sugar

The following substitution for the components of the ration may be made when deemed necessary by the senior officer present in command. Articles of combined ration components will be regarded as ration equivalents and issued in accordance with the following table [2]:

[1] Naval Act of June 29, 1906, and March 2, 1907.
[2] Memo. No. 74, Navy Dept., Sept. 1, 1915. For the guidance of officers, beginning with the second quarter of the year 1916.

NAVY RATIONS AND COMPONENTS

Components	Ration allowance
Bread:	
Biscuit	1 pound
Crackers:	
Soda	1 "
Oyster	1 "
Bread, fresh:	
Wheat	1¼ pounds
Graham	1¼ "
Rolls	1¼ "
Flour:	
Wheat	1⅛ "
Graham	1⅛ "
Buckwheat	1⅛ "
Corn meal	1⅛ "
Meat:	
Preserved:	
Tinned:	
Bacon	1 pound
Corned beef	1 "
Chipped beef	1 "
Codfish and haddock	1 "
Salmon	1 "
Sardines	1 "
Sausage (Vienna)	1 "
Luncheon meat	1 "
Salt:	
Corned beef, fresh	1¼ pounds
Salt pork	1¼ "
Salt mackerel	1¼ "
Smoked:	
Bacon, sugar cured and smoked	1¼ "
Ham, sugar cured and smoked	1¼ "
Shoulder, sugar cured smoked	1¼ "
Sausage, frankfurters	1¼ "
Sausage, bologna	1¼ "
Tongues, beef	1¼ "
Fresh:	
Beef	1¾ "
Mutton	1¾ "
Pork	1¾ "
Veal	1¾ "
Sausage, pork	1¾ "
Liver, beef	1¾ "
Meat: (*Continued*)	
Fresh: (*Continued*)	
Hamburger steak	1¾ pounds
Chicken	1¾ "
Fowl	1¾ "
Turkey	1¾ "
Fish, fresh	1¾ "
Eggs	8 (number)
Vegetables:	
Dried:	
Beans:	
Navy	3 gills
Lima	3 "
Kidney	3 "
Peas, split	3 "
Canned:	
Beans:	
Lima	¾ pound
String	¾ "
Corn	¾ "
Peas	¾ "
Tomatoes	¾ "
Pumpkin	¾ "
Beets	¾ "
Fresh:	
Turnips	1¾ pounds
Carrots	1¾ "
Tomatoes	1¾ "
Beets	1¾ "
Onions, green	1¾ "
Squash	1¾ "
Pumpkin	1¾ "
String beans	1¾ "
Peas, green, in pod	1¾ "
Corn, green, sugar, on cob, in husk	1¾ "
Spinach	1¾ "
Cauliflower	1¾ "
Lettuce	1¾ "
Cucumbers	1¾ "
Celery	1¾ "
Radishes	1¾ "
Rhubarb	1¾ "
Parsnips	1¾ "

NAVY RATIONS AND COMPONENTS—*Continued*

Components	Ration allowance
Vegetables: (*Continued*)	
Fresh: (*Continued*)	
Eggplant	1¾ pounds
Peppers, green and red	1¾ "
Asparagus	1¾ "
Parsley	1¾ "
Potatoes:	
Irish	1¾ "
Sweet	1¾ "
Onions	1¾ "
Cabbage	1¾ "
Cereals and starch foods:	
Rice	½ pound
Cornstarch	½ "
Barley	½ "
Hominy	½ "
Oats, rolled	½ "
Tapioca	½ "
Fruit:	
Dried:	
Apples	3/16 "
Citron	3/16 "
Currants	3/16 "
Cocoanut, shredded	3/16 "
Peaches	3/16 "
Raisins	3/16 "
Canned:	
Apples	⅜ "
Apricots	⅜ "
Peaches	⅜ "
Pears	⅜ "
Pineapple	⅜ "
Prunes	⅜ "
Preserved:	
Jams	⅜ "
Apple butter	⅜ "
Mincemeat	⅜ "
Fresh:	
Peaches	9/16 "
Pears	9/16 "
Cherries	9/16 "
Grapes	9/16 "
Berries, all kinds	9/16 "
Cranberries	9/16 "
Watermelon	9/16 "
Cantaloupe	9/16 "

Components	Ration allowance
Fruit: (*Continued*)	
Fresh: (*Continued*)	
Plums	9/16 pound
Grapefruit	9/16 "
Pineapple	9/16 "
Apples	9/16 "
Bananas	9/16 "
Lemons	9/16 "
Oranges	9/16 "
Beverages:	
Coffee	⅛ "
Cocoa	⅛ "
Tea	1/32 "
Milk:	
Evaporated	1/16 quart
Fresh	1/16 "
Extracts, flavoring:	
Vanilla	As needed
Lemon	" "
Vinegar and sauces:	
Vinegar	½ pt. weekly
Oil, salad	½ " "
Sauce, Worcestershire	½ " "
Catsup	½ " "
Butter	⅛ lb. daily
Cheese	¼ " "
Baking powder	As needed
Baking soda	" "
Hops	" "
Lard	7 lbs. to every 100 lbs. flour as bread
Oil, cottonseed	As lard substitute in the proportion of 1 gal. to 10 pounds lard
Macaroni and vermicelli	½ lb. weekly
Mustard	1/32 " "
Pepper, black and cayenne	1/32 " "
Pickles and sauerkraut	¼ " "
Salt	¼ " "
Syrup	¼ pt. "
Spices, assorted	1/128 lb. "
Sugar	¼ " daily
Yeast	As needed
Tomatoes	¼ lb. weekly

The extra allowance of

2 ounces sugar
4 ounces hard bread or its equivalent
1 ounce coffee or cocoa
4 ounces preserved meat or its equivalent

is allowed to enlisted men of the engineer and dynamo force who stand night watches between eight o'clock P.M. and 8 o'clock A.M., under steam.

According to provisions promulgated by the Secretary of the Navy[1] any article comprised in the navy ration may be issued in excess of the authorized quantity provided there is an under-issue of the same value in some other article or articles of food.

Gatewood, in discussing navy rations, says:

> Contentment in naval service in relation to food and water makes for good discipline, and work without contentment is impossible. Contentment facilitates voluntary enlistment, and a service that supplied protein food in amounts exactly to meet the requirements of the body as evolved from the mathematics of nitrogenous equilibrium would not secure contentment. That is the basis of the daily amounts of food in the navy ration, the amounts depending essentially not upon what it is thought men ought to eat, but upon what experience has demonstrated they desire to eat.

The navy ration has been particularly studied and carefully arranged from the point of view of efficient service. The variety and components permit of sufficient elasticity to prevent monotony in the dietary. The selection of food is of great moment and with the aid of preserved and canned meats, fruits and vegetables, quite a variety in the dietary can be furnished aboard ship. The ration aboard ship will vary according to climatic conditions. The dietary in tropical countries will be different from that in cooler regions. Appetite and digestion are influenced more or less by changing temperatures and humidity. It is also quite probable that the efferent nerve supply on the surface of the body reacts to external climatic influences and exerts a retarding effect upon metabolism. Precise information as to the energy or nutritive value of the navy ration is not readily obtainable without carefully taking into account whether the energy or fuel value should be reckoned on the ration as issued, or as consumed. Surgeon Gatewood, U. S. N., worked out a table showing the comparative average energy values of the ration of the United States navy as contrasted with those of the navies of other nations. He summed up the subject in the following table, showing the various percentage

[1] Naval Act, March 2d, 1907.

elements of the dietary ingested and digested and the actual energy or caloric values of each:

COMPARATIVE NUTRITIVE ENERGY OF AMERICAN AND FOREIGN NAVY RATIONS

NAVAL DIETARIES	EATEN			DIGESTIBLE				
	Protein	Fat	Carbohydrates	Protein	Fat	Carbohydrates	Utilizable energy	Nutritive ratio
	Gm.	Gm.	Gm.	Gm.	Gm.	Gm.	Gals.	1
1. U. S. Navy (sea ration)	138	269	556	127	256	540	5,180	8.7
2. U. S. Navy (fresh provisions)	145	135	444	134	129	431	3,563	5.3
3. U. S. Navy (usual)	142	192	492	131	183	478	4,256	6.7
4. U. S. Navy (engineer force)	182	218	624	168	207	606	5,174	6.3
5. Japanese Navy (average)	126	56	607	116	53	589	3,430	6.1
6. French Navy (average)	170	34	524	156	32	508	3,078	3.7
7. French Navy (engineer force)	184	35	608	169	33	590	3,407	3.9
8. British Navy (average)	127	110	601	117	104	583	3,891	7.2
9. British Navy (engineer force)	175	149	728	161	141	706	4,938	6.6

The estimates in Gatewood's table concerning the percentage elements of the ration of the French navy must be accepted with a little reservation, since it is not clear whether all the necessary factors have been included or whether correct allowance has been made for waste. It may be that the ration is given as *issued* and not as *consumed.* The percentage elements recorded for the Japanese navy seem to be rather low, but it must be taken into consideration that the weight of the average enlisted man in the Japanese navy is only about 129 pounds. It will be seen from the examination of this table that the average sailor in the United States navy consumes daily, 142 grams of protein, 193 grams of fat, and 492 grams of carbohydrates, yielding a fuel value of 4,256 calories. The engineer force receives an additional issue of 42 grams of protein, 24 grams of fat, and 122 grams of carbohydrates. This allowance gives the engineer force more protein than is given in Atwater's Standards for a man at hard muscular labor.

In arranging the navy ration, several points of view must be taken

into consideration. First, the ration must be what the sailor should have, and second, it ought to be what he wants. The availability of the ration, its keeping qualities and its storage are also matters to be carefully considered. Again, the all important question of securing an aliment which will yield the proper amount of nutriment within a fixed daily cost per capita must be taken into consideration. These and many other pertinent questions have been very carefully and satisfactorily considered in an excellent article by Surgeon J. D. Gatewood of the United States navy in his work on "Naval Hygiene."

The United States navy, by authority of its secretary, has issued a "General Mess Manual and Cook Book"[1] for use on board vessels of the United States navy, which gives much interesting data concerning the organization and administration and general management of the Commissary of the United States navy.

PART I. THE GENERAL MESS

Organization and Administration.—1. The general messing system is, by regulations, obligatory on board of all vessels of the Navy. The mess must include all enlisted men of the Navy and Marine Corps, except chief petty officers and officers' servants, and its members are to be divided into messes of about twenty men each, and as nearly as possible messed by divisions instead of by rations, as has heretofore been the custom. By this method the petty officers will be scattered among the messes and there can be no complaint on account of discrimination—all faring alike.

2. A messman is to be detailed for each mess, and he is to receive the food from the cooks at the galley, serve it at the mess table, and is responsible for the care and the cleanliness of the mess gear and mess tables.

3. The chief commissary steward, or commissary steward, the cooks and bakers, together with the storekeeper (when a store is established on the ship), form the enlisted force of the commissary department. They are the assistants of the pay officer and belong to the pay division.

4. The responsibility of the commissary and his assistants ceases with the delivery of the food to the messman at the galley.

5. The established rate of pay being sufficient to secure the services of competent and experienced men, the payment of any gratuity, either by the commissary or by the men themselves, to any person employed in the service of the general mess is forbidden by the regulations.

6. The commanding officer should see that proper facilities, including such boats and men as may be necessary, are afforded the commissary for getting mess stores on board and stowing them.

[1] Government Printing Office, Washington, D. C., 1904.

7. It should be thoroughly understood that the general mess is not an organization managed by its members, as was the "berth-deck mess."

8. In addition to the pay provided for enlisted men, the Government undertakes to subsist them, and this it does at whatever expense may be necessary. The fixed value of commutation for one ration is, by law, 30 cents, but the commutation of rations is a privilege, not a right, and the idea prevalent among enlisted men that they are entitled to receive just 30 cents' worth of food each day or 30 cents in money, is erroneous. While the regulations limit commutation to one-fourth the total number of rations, they do not require any commutation at all, this being purely a question of desirability and business expediency to be decided by the pay officer with the approval of the commanding officer.

9. Under the general messing system the Government subsists the men entirely, and they have no more voice in the management of the commissary department than in any other department of the ship. The Government, through its authorized officer, provides them with the ration allowed by law. The food is purchased, cooked, and served entirely at the Government expense, and its value, whether it be more or less than 30 cents per diem per man, is a matter with which the men themselves have nothing to do.

10. In case any man considers that he is improperly subsisted, he has the right, which all persons in the Navy have, to state his grievance at the proper time and place to his commanding officer, who should then cause the commissary to investigate the matter, and, if the complaint is well founded, to take steps to place the responsibility and to prevent a recurrence of the fault complained of.

11. The men are entitled to the full benefit of the money and stores allowed for their subsistence, and no expenditure can be made from the general mess fund, except for the benefit of the mess; nor can any of this money or these stores be withheld (when they can be used to advantage) and allowed to accumulate as a surplus. In cases, however, where a surplus of either money or stores does unavoidably exist when a ship is placed out of commission, the members of the mess have no claim whatever to any part of it and it reverts to the Government, the stores being taken up as a gain on issues and the money being credited to the appropriation "Provisions, Navy."

12. Subsistence of enlisted men absent from the ship on duty will, when practicable, be furnished by the general mess. When men are landed in large numbers for an expedition or for going into camp with the expectation of being absent from the ship for more than twenty-four hours, the paymaster's clerk or the commissary steward, or both, according to the proportion of the ship's company landed and the importance of the expedition, together with such cooks and bakers as may be necessary, and a sufficient number of messmen, should constitute the commissary corps.

13. Special attention is invited to Articles 387, 391, 392, 753, and 1402, Navy Regulations, as amended by General Orders 68, 105, and 119. It will be noted that the board of audit is required to make its report to the commanding officer monthly and in writing; its recommendations being based upon facts adduced in the audit of the mess accounts, and confined to its financial feature alone.

The Commissary.—14. The pay officer of the ship, or, in ships having no pay officer, an officer designated by the captain is the commissary, and is solely responsible for the purchase and preparation of the food for the general mess, the care of the stores, and the judicious expenditure of mess funds, keeping the accounts of the mess and administering all its affairs except the serving of the food at the mess table.

15. His authority in the performance of these duties is commensurate with his responsibility, and all persons employed in the service of the general mess are subject to his orders.

16. The commissary should frequently inspect the storerooms allotted to the general mess and see that the stores are properly stowed and that the rooms are dry and well ventilated. Any deterioration in the stores being a direct loss to the mess, great care should be exercised in their selection, and no greater quantity should be bought at one time than can be used within the period they may be expected to keep in good condition.

17. The commissary should not permit any stores to be purchased until a list of them has been submitted to him and carefully examined and approved. No stores should be received on board unless accompanied by a bill or memorandum by which they can be checked off; and before being stowed away all stores should be carefully inspected by the commissary or the commissary steward. No bills should be contracted that can not be paid from the funds in hand or by the ration money that will accrue to the mess during the current month. All bills should be settled at the end of each month, and always before the ship sails from port.

18. The commissary should keep the cash accounts of the mess so that they can be conveniently audited by the general inspector of the pay corps, the paymaster of the fleet, or by the board appointed for the purpose. All expenditures must be substantiated by vouchers, which are to be exhibited when the accounts are inspected.

19. He should cause the commissary steward to keep a stock account which should embrace all stores and all property of the general mess. The value of the balance shown upon this stock account should be taken into consideration in making up the statement of the financial condition of the mess.

20. The commissary should, when he deems it advisable, submit written reports and recommendations to the captain regarding the general mess, and he must do so whenever the interests of the mess require any change which he, himself, is not authorized to make.

21. The commissary should mark the enlisted men of his department in proficiency in rating and should immediately report any inefficiency or carelessness in their performance of duty.

22. He should frequently inspect the food before it is delivered to the mess men at the galley, and in case he finds it improperly prepared, should take steps to prevent any further occurrence of the kind. If cooks are not thoroughly com-

petent, they should be made to follow strictly the recipes in this book, and flagrant cases of incompetency should be reported.

The Commissary Stewards.—23. The chief commissary steward or commissary steward is the chief petty officer in charge, under the commissary, of the general mess. He is entitled to respect and obedience from all persons of inferior rating while in the performance of his duties, and he is responsible for the proper execution of the orders of the commissary. The daily bill of fare should be made out by the commissary steward and submitted to the commissary, and the necessary stores issued to the cooks at the galley. He should direct the manner of its preparation and shall be in charge of the galley and the men employed at it, and should frequently inspect the food before it is delivered to the messmen to be served. He should see that the galley and all the galley utensils are kept in proper condition, giving particular attention to their cleanliness.

24. He should report to the commissary daily, in writing, all purchases made and debts contracted, and keep that officer advised of the needs of the mess. He is to draw from the pay department, at the appointed time, such government stores as are due the mess, and must keep an account of these stores for the verification of the provision return at the end of each quarter. When fresh provisions are issued he should be on deck, when practicable, to receive them from the representative of the pay department as soon as they have been received on board and inspected. In case these fresh provisions, or any other stores issued to the mess by the pay department are, in the opinion of the commissary steward, of inferior quality and unfit for issue, he should report the matter to the commissary, who shall make a personal investigation, and, in case he finds the objection well founded, should take the necessary steps to provide other stores, as prescribed by the regulations. An issuing book should be kept by the pay yeoman and signed daily by the commissary steward, in order that no question may arise at the end of the quarter as to the stores drawn by the general mess. The commissary steward may, with the authority of the commissary, draw from the pay department such government stores as are required in excess of the allowance, and these stores shall be paid for from the mess fund at the end of each month.

The Cooks.—25. The senior cook, or, if there are two or more of the same rating, one selected by the commissary, should be in immediate charge of the galley and act in the capacity of head cook. He should be held strictly responsible for the cleanliness of the galley and the utensils pertaining to it, for the maintenance of discipline among his assistants, for the proper preparation of the food, and for having the meals ready at the prescribed hours. He should personally superintend the cooking of all meals, and should carefully inspect all food before it is delivered to the messmen. It is his duty to report to the commissary any inefficiency or neglect on the part of his assistants; otherwise the entire blame for poor cooking or any other delinquency at the galley should rest upon him. The head cook should keep the commissary steward informed as to the requirements of the galley, and should from time to time prepare lists of articles required by him in his cooking, which are not included in the Navy ration. He is responsible for the galley utensils and will report immediately when they are lost or damaged.

26. The other cooks should, as far as possble, be assigned specific duties at the galley in order that the responsibility for any neglect may readily be placed. One should be detailed as "meat cook," another as "vegetable cook," and one man should, in addition to other duties, be held responsible for the preparation of the coffee and tea.

27. The cooks in the lower ratings should be detailed for starting fires, cleaning the galley and utensils (regular cleaning stations being assigned them) and for preparing the food for cooking.

28. The organization of the force at the galley should be as complete and efficient as that of a gun division.

The Bakers.—29. The commissary steward should issue to the baker such quantities of flour and other ingredients as may be necessary for making bread for the mess and keep him advised of the amount of bread required from day to day.

30. The baker, or, in ships which are allowed two bakers, the baker first class, is to be held responsible for the proper baking of the bread and for its delivery to the messmen at the appointed times. He is also responsible for the condition of the bake ovens and the utensils used by him.

PART II. THE COMMISSARY STORE

Establishment and Administration.—31. There being no public funds available for the establishment of a store on board ships of the Navy, such establishment is not made compulsory, but is left to the discretion of the commanding officer. The advantages of such a store are, however, so obvious and so great that provision is made in the regulations for its administration in ships where it exists, or may be established.

32. The objects of a commissary store are:

(1) To enable the men to purchase a better quality of the articles usually obtained from bumboat men, and at a lower price.

(2) To return directly to the men all profits from their purchases not needed for carrying on the business.

(3) To bring under official control the sale of all merchandise on board ship, and thus do away with bumboat men and peddlers, and reduce the chances of liquor or other unauthorized articles being brought on board. The sale of any merchandise on board ship, except by the store, should be prohibited as far as practicable. Tailors, persons doing repairing, and those selling special articles which cannot conveniently be handled by the store, may be exempt from this prohibition, but dealers in milk, pies, fruit, and such articles should not be allowed to sell to the men.

33. The commissary should make agreement with reliable merchants to supply to the store, while the ship is in port, such stores as are salable but cannot be carried in stock, and these articles should be delivered to the storekeeper and

by him sold to the men at a very small advance. For example, if it be thought advisable to have milk for sale in the store when the ship is in port, the commissary should arrange with a dealer to place on board, at a specified time each day, a quantity of milk at a fixed price, such quantity as may be sold to be paid for, and the balance to be taken away by the dealer.

34. The stock being purchased from reliable firms at wholesale prices, will be better in quality and lower in price than that usually carried by bumboats or itinerant merchants. The greater part of the retail dealer's profit should revert directly to the purchaser at the time he buys the article—that is, the price charged should be very little, if any, above the wholesale price. Such small profits as may from time to time accrue shall be expended by the pay officer in such manner as the commanding officer deems most conducive to the pleasure and comfort of the enlisted men. No part of these profits, however, is under any circumstances to be transferred to the general mess for the purpose of supplementing the authorized ration.

35. In ships where the men desire to subscribe for the original stock of a commissary store, and the commanding officer authorizes its establishment, the commissary is, by the regulations, placed in charge of it. This officer is to receive voluntary subscriptions from the crew, giving them receipts (stated to be not negotiable) for the amount subscribed, with the agreement that these receipts may be surrendered and the amount of the subscription refunded after the original stock has been paid for and the business is on a good financial basis. The original subscribers, after they have been paid the amount of their subscriptions, have no further claim upon, nor interest in, the store.

36. During this period it is advisable to make the prices correspond with those of retail dealers in order that the store may be independent as soon as possible, but when all indebtedness has been discharged and the store is self-supporting, the profits should be reduced to a minimum, it being always borne in mind that making money is not one of the objects of the store. The injustice of making profits from sales to one set of men to be divided among another set at the expiration of a cruise is manifest, and for this reason the regulations provide that such profits be used to improve the bill of fare of the general mess, but with the present ample ration no addition to the mess fund should be necessary; and by reduction in prices from time to time, as experience dictates, the monthly surplus should be reduced to a minimum, thus disposing of the regular retail dealer's profit in the most equitable manner possible, i.e., by giving the benefit of it to each purchaser in the form of a discount.

37. It is impracticable to operate a store unless a suitable room, used for no other purpose and to which only the storekeeper has access, is available for the purpose.

38. The commissary of the ship has charge of the ship's store. He is allowed the services of a yeoman for duty as storekeeper. The commissary should give his personal attention to the purchase of stock for the store, should fix the prices at which the articles are sold, establish a businesslike system for the operation of

the store, and direct all its affairs. He shall keep the cash account and cause the storeman to turn in daily all money not required for making change.

39. All the accounts of the commissary store should be kept in such manner as to admit of ready inspection by the general inspector of the pay corps, the paymaster of the fleet, or by the board appointed for that purpose.

40. The storekeeper should be responsible to the commissary for the proper conduct of the store. He is to keep the account of the stock, and of the sales, and submit to the commissary from time to time lists of articles required.

41. In order to protect the store from any loss, either through carelessness or dishonesty, the following method of keeping the accounts should be employed:

At the end of each month an account of stock should be taken, and the articles found to be on hand entered in a book similar to the return of clothing and small stores. (This blank may conveniently be used for the purpose, the headings of the columns being changed.) These quantities represent the stock on hand at the beginning of the new month and to them should be added all stores received from purchase. At the end of the month the quantities found to be on hand should be entered in the proper line and subtracted from the total receipts and the difference entered as "sales." By multiplying the number of each article sold by its selling price and taking the total of that line in the return will be found the amount which the storekeeper should have received, and this amount he should be required to turn in or account for.

42. If no prices are changed except at the beginning of a month, and if the established prices are displayed on the store bulletin board so that no overcharges can be made, this system will be a simple and absolute check on the storekeeper.

43. The man selected for this responsible duty should first of all be entirely trustworthy. He must be quick and accurate at figures and write legibly. It is his duty to receive such stock as may be delivered for the store, conveniently arrange it in the storeroom, and keep the latter clean and see that it is ready for inspection at the appointed time. He is to open the store for the sale of merchandise to the men at such times as may be appointed by the commissary, with the authority of the captain. He should keep a small memorandum book in which to enter the amounts turned in daily to the commissary, and when that officer receives the money, he should initial the amount in the book.

PART III. THE PREPARATION OF FOOD

The Ration.—44. The dietary of the enlisted men of the Navy must necessarily be based upon the ration provided by law. In general messes, where the circumstances are favorable, provisions which are not a part of the ration may at times be purchased, but articles of which there is a supply already on board in the pay department should not be bought unless the government stores shall have deteriorated, in which case they should be surveyed and a new stock obtained at the first opportunity.

45. Unless there be some good reason for not doing so, the official issuing table should be strictly adhered to, it having been arranged to give the necessary variety.

The Galley.—46. The ship's galley (or that part of it used by the general mess), together with its appurtenances, is under the charge of the commissary. That officer should see that the galley and its utensils are properly cared for and are ready for inspection at the appointed times. He should himself frequently inspect this part of his department and advise the equipment officer of any repairs or alterations needed, and should, when occasion demands it, furnish that officer with a list of galley utensils requiring a survey.

Cooking.—47. On board ship, where the facilities are necessarily restricted and the food lacking in variety compared to that obtainable on shore, it is of the highest importance that the very best results possible under the circumstances should be obtained. With a liberal allowance of cooks and bakers, and a judicious selection of the men for these rates, the Navy ration should be so prepared as to give the enlisted men three nourishing and palatable meals each day, and it should be the duty of the commissary department to see that this is done. Frequent inspections of the food by the commissary and the commissary steward, and efficiency on the part of the cooks alone can insure this.

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CHAPTER XIX

FOOD ECONOMICS IN WAR

Food Situations in Countries at War: Germany, Great Britain.
Use of Certain Foodstuffs in War: Bread and Cereal Foods; Milk, Sugar; Alcohol in War Economies; the Food Situation in the United States.
Summary.

Out of evil good may come, and, of course, this saying is as true of war as of any evil thing. So far as the food question is concerned, many valuable lessons have been learned with respect to food values, and although at the time of writing, the war is still in progress, with no signs of a speedy end, it has been felt by the author that a work on diet written at such a period would not be complete unless the matter of feeding populations shut off from most or many of their ordinary sources of supply was at least discussed. Perhaps no really definite lessons as to food can be learned until the conflict is over, but, on the other hand, a good deal of valuable information has already been collected, and some of the facts brought out should not be passed over.

For example, it has been proved beyond peradventure that not only can the physical equilibrium be maintained without luxuries—this was known before—but that, if a diet is well balanced, the energy and heat necessary to keep the human machine in good working order can be provided by a quantity considerably less than would have been considered adequate in the piping days of peace. The lesson has been fairly well learned by the inhabitants of some of the countries at war that food can be reduced to the exact requirements of the human machine, with much benefit to the smooth working of that machine. The members of the medical profession have long preached—and their preaching has been as the voice of one crying in the wilderness—the doctrine of self-control in the matter of food. The evils of gluttony or of eating to excess have been enlarged on in Volume II, Chapter VI, and the fact that governments, for the purpose of high politics, have had to step in to heal, in spite of

themselves, many unsuspected victims of gluttony,[1] possesses a decidedly ironical aspect. The experience of the war has proven, once and for all time, that the majority of well-to-do persons persistently eat more than is good for health, and has clearly demonstrated that the diet to which an individual has become addicted by custom, and which he has brought himself to believe the most nutritious, is often surpassed by articles of diet which he has been wont to despise as cheap and lacking in strength and energy-giving properties.

FOOD SITUATIONS IN COUNTRIES AT WAR

Germany.—The European war afforded an unique opportunity, though an unsought one, to study the relation of the food supply to unexpected economic and territorial conditions. In Germany, in particular, the situation was unparalleled owing to the exclusion of the greater part of the food which in normal times was obtained from abroad. Germany had been in the custom of procuring most of her wheat, rice and other foods from Russia. This source of supply was completely cut off. From the Scandinavian countries she had obtained a large proportion of butter, eggs and lard, and from America both foods and crude materials which were applied to animal production. With all these external sources of supply threatened or wholly cut off, the question presented itself, how were the inhabitants, civil and military, to be fed, relying, perhaps, mainly on internal resources.

With the organizing ability and scientific acumen with which the Germans have long been credited, their professors and business men proceeded to attack the problem, and in the early days of the war Dr. Paul Eltzbacher, acting Rector of the Berlin High School, edited a pamphlet in which leading experts discussed the problems of the food supply in Germany and the means to be taken for assuring adequate provision for all the inhabitants. According to this pamphlet, the export of native products, such as sugar and rice, was to be restricted; the feeding of materials suitable for human consumption to cattle was to be greatly decreased. Conservation of food values ordinarily lost in the processes of conversion into animal tissue was to be brought about; unjustifiable waste was to be avoided not only on a large scale but even in the individual kitchen. The minuteness and the elaborate nature of the study were indicated by such details as reminders that twenty grams of fat per capita

[1] The evils of gluttony or of eating to excess have been enlarged upon in Chapter VI of this volume.

were lost in the sewage waste of Berlin every day, and that this ought to be prevented.

The inhabitants, on the authority of well-known scientific men, were assured that changes of dietary regimen intelligently carried out need cause no alarm, as the public health would not suffer thereby. Pamphlets were widely distributed in which the laws governing nutrition were proclaimed and suitable dietetic advice was given. It was urged that plant products, rich in carbohydrates, should be more liberally used and that the consumption of meat, rich in proteins and fats, should be restricted. The substitution of the regimen of South German households in the place of the excessive meat diet of the northern provinces was strongly recommended. Even a cook book for war time was freely distributed, and the services of German chemists were requisitioned to supply by the aid of their science substitutes for some of the lacking food products.

Another pamphlet was issued in the early part of 1916, the authors of which were Professors Kuczynski and Zuntz of Berlin. On Jan. 25, 1915, the German government took the supplies of wheat and rye into its own hands and decreed that those engaged in agriculture should have an allowance of 7.2 kilograms of flour per month per head, and the rest of the population 225 grams daily per head. In February, the allowance of 225 grams was reduced to 200. In time of peace the average consumption per head was 340 grams, so that the people as a whole had to deny themselves 14 per cent of their accustomed nourishment, and the poor, with whom bread is a more important item, 25 per cent.

For the first six months of the war, the condition of the food supply was not less favorable than in time of peace. Food prices had risen steadily, although in many trades wages had risen correspondingly. Later on, as the cereal supply began to run short and a bread ration was fixed, the poorer classes lost about 20 per cent to 25 per cent of their staple diet. The price of rye bread in January, 1915, had risen 33 per cent, and in May, 53 per cent; while wheat bread had advanced 26 per cent and 35 per cent as compared with prices in January, 1914, and May, 1914. With other foods, prices had risen on an average of 81 per cent from May, 1914, to May, 1915. This great rise in prices forced the mass of the people to buy the cheaper kinds of foods and also to buy smaller quantities. A great deal of the difference was accounted for by more careful cooking and usage, as cooking potatoes in their skins; but in such foods as meat, milk, etc., such a saving was not possible. Briefly, the situation from February or March, 1915, onwards, was one of enforced moderation, with health-giving results to hundreds of thousands

of over-fed people, but implying for the masses a weakening of their working capacity by hardships which amounted to actual want.

The second chapter of the Kuczynski and Zuntz pamphlet dealt with the right division of food between man and beast, into which there is no space to enter at length. The importance of sugar as a foodstuff was dwelt upon, not only as a food, but as a means of preserving large quantities of fruit and vegetables.

The finding of new fodder, consequent upon the reservation for the use of man of foodstuffs which used to be employed for animal-feeding purposes, was a feature of the situation. In the search for new fodder it was recommended that the forests of leafy trees might supply nutriment for pigs and cows. The comparative nutritive value of the various leaves is shown in the following table, giving the amount of protein and starch obtained from 100 kilograms of each raw material:

COMPARATIVE NUTRITIVE VALUE OF VARIOUS LEAVES

Species of Fodder	Digestive Protein	Starch
	Kg.	Kg.
Elm leaves (young)	11.7	50.0
" " (old)	9.7	38.8
Acacia leaves	26.6	54.0
Horse-chestnut leaves	11.3	41.7
Poplar leaves in October	6.0	26.7
Copper beech leaves in August	0.9	16.7
Vine leaves in autumn	6.7	42.5
Acacia brushwood in winter	5.5	12.6
Good meadow hay	5.5	31.8
Oat straw	1.3	17.4

In order to make the best possible use of leaves, it must be borne in mind that during the day the action of light draws considerable quantities of starch and sugar into the leaves, some of which returns during the night into the woody parts, so that the leaves are of the most nutritive value towards evening, when they should be gathered. Towards autumn the leaves are less nutritious as well as less digestible, but, on the other hand, they contain less water and are more easily dried. This use of leaves especially should meet the case of the poorer people in town and country who keep one cow or a few goats. This is a lesson that has been learned from the war.

Haberlandt was quoted by the authors as having revealed another

source of supply in the woods, the sapwood of trees in early spring, with its high content of starch and fat. To obtain nutritive matter from straw and wood, certain methods are available. The most recent method is the use of organic acids which are in themselves of value as fodder, as lactic acid. The significance of this method lies in the fact that not only is much cellulose converted into digestible carbohydrate, but the remaining nutriment in the cellulose coverings is exposed at the same time to the action of the digestive juices of the animal.

In the search for new fodders, heather was not overlooked, especially as it contains very little water, and is therefore easy to dry. Of the highest importance in storing foodstuffs is the question of drying, not only for animals, but as a means of preserving food in concentrated form for man also. The drying of turnip scraps and turnip leaves, of the leavings of the malt in beer brewing, of the distiller's and other waste products from various industries, has long been practiced to a large extent, sometimes by means of gas, sometimes by steam heating. The hay crop can be increased by 20 per cent or 30 per cent by increased facilities for drying.

The following table shows the percentage loss in nutrient material by the tardy drying of hay:

LOSS FROM TARDY CURING OF HAY

Time taken for drying	Protein	Fat	Nitrogen-free extractives	Fiber	Mineral salts
10 days	9.9	49.5	16.3	2.5	12.8
20 "	45.8	72.9	46.6	27.7	48.6

The authors were of the opinion that the drying process was not only useful for fodder but also for foodstuffs. In the household it could be done on the hearth, in the oven, or in the open air. Not only the usual fruits, such as plums, apples, cherries, bilberries, etc., should be preserved by these means, but also potatoes, either raw or in slices, or boiled in their skins and then mashed. Further, since drying factories could not be built fast enough, pickling methods must be improved by the employment of the culture of bacilli. Even in the case of withered turnip tops the Institute of Fermentation Industries at Berlin found that by placing them in large quantities in cemented pits and treating them with a culture of lactic acid, loss by fermentation was considerably reduced.

Among the many lessons which the war has taught in the matter of diet is that when woman works at manual labor in the open air, cultivating the fields, for example, as she has in England and Germany, she needs a ration liberal in proportion to the expenditure of energy. This was a matter that was somewhat overlooked in the calculations as to economizing the food supply.

Another important lesson that has been learned is that fat is a factor of more prominence than was generally believed in the scheme of nutrition. While fat formed a fair proportion of a German diet in the ordinary way, the production of fat has not been encouraged or stimulated by the German agricultural system. As early as the autumn of 1915, in addition to two meatless days in the week, the German regimen ordered the introduction of two fatless days. German writers generally, following Voit, have rated the desirable amount of fat in the daily ration at 56 grams, almost 2 ounces to 100 grams, for men at hard manual labor in the open air. It has been taught by them that with increase in the body's demand for available food fuel, it is preferable not to increase too largely the carbohydrate intake, which is usually put at about 500 grams, but rather to add to the quota of fat in about the proportion indicated by the above quoted figures. It must be borne in mind that an increment in fat can be obtained with far less increase of bulk than a comparable augmentation of carbohydrate-containing foods will permit. A gram of fat yields more than twice the energy that is yielded by the same unit weight of the other available nutrients.

Dr. Alonzo E. Taylor, who was in Germany during a part of the war, and was afforded special facilities for studying the food question at first hand, gave the results of his experiences and deductions drawn therefrom in a series of exceptionally able articles contributed to the *Saturday Evening Post* in the early part of 1917, from which the author has drawn largely in the preparation of this section. He stated that in 1915 the fat intake in Germany was not more than 20 grams, animal and vegetable, per capita per day. While this is certainly more than enough to cover the needs in fat soluble vitamines and is twice the intake of fat of the Japanese, the fact remains that the people were hungry. The consumption of fat in Germany prior to the war was about 3½ ounces per capita per day, of which nearly half was obtained by importation, directly or indirectly. As the cultivation of fat-producing materials had not been encouraged, and as the partial blockade to which Germany was subjected very greatly restricted the importation of fat upon which the country largely depended for its supply, the inhabitants had to go without a good deal of

the fatty ingredients of diet to which they were accustomed. Fat being a fertile source of energy, they suffered much from this deprivation.

The following table culled from Taylor's paper(1) contains the estimates of four different calculations as stated for protein, fat, carbohydrate and calories per head per day of the food consumption of Germany based on official data for the years 1912 and 1913.

CONSUMPTION OF FOOD UNITS IN GERMANY, 1912–1913

Observer	Total				Imported				Domestic			
	Protein	Fat	Carbohydrate	Calories	Protein	Fat	Carbohydrate	Calories	Protein	Fat	Carbohydrate	Calories
	oz.	oz.	oz.		oz.	oz.	oz.		oz.	oz.	oz.	
Ballod	3.10	2.15	14.5	2,708	0.85	0.88	0.8	450	2.25	1.30	13.5	2,480
Eltzbacher	3.30	3.75	18.7	3,642	0.90	1.60	1.5	715	2.40	2.10	17.2	2,927
Kuczynski and Zuntz	3.70	3.11	20.1	3,550	1.13	1.06	1.4	473	2.57	2.05	18.7	3,077
Taylor	3.25	2.33	16.0	2,790	0.90	1.06	1.4	550	2.35	1.27	14.6	2,204

In the Eltzbacher report the German population was put down as 68,000,000. The number of children of each year and the number of adult males and females were known. The figure for the number of children of each year of age was multiplied by the figure for the food need of that year. The number of adult females and the number of adult males were multiplied respectively by 85 and 100. The final figure for the needed food units, a compromise between several standards, was 51,822,908.

This means that the population of 68,000,000 would be nourished if it received the ration of 51,822,908 adults. Three thousand calories was the figure set for the adult need. The caloric needs of the German people were, therefore, determined by the simple multiplication—3,000 x 365 x 51,822,908 = 56,750,000,000,000 calories. When this figure for total calories, determined on the basis of man ration, was divided by the figure for the population, the result was 2,280 calories a day. The protein needs of the people were also calculated. Children under six years of age were allotted 1.4 ounces a day; from six to twelve, about 1.75; from twelve to eighteen, about 2.3. Adult men were allotted 2.9 ounces; adult women, 2.4.

Taylor, taking into consideration that all work harder in war time, especially women, and further considering that the estimate for children

from 12 to 18 was too low, calculated the protein and caloric needs of the German people in war time as follows: protein, 1,524,000 tons; calories, 63,000,000,000,000.

The protein needs as set forth by figures supplied by Eltzbacher, Taylor and Chittenden are as follows:

PROTEIN NEEDS IN OUNCES

	Per Capita	Man Ration
Eltzbacher	2.30 oz.	2.83 oz.
Taylor	2.15 war-time	2.5 "
Chittenden	1.5 "	1.8 "

CALORIC NEEDS

	Per Capita	Man Ration
Eltzbacher	2,380 peace-time	3,000
Taylor	2,510 war-time	3,300
Chittenden	2,030	2,600

The peace-time consumption of protein in Germany, according to the Chittenden standard, was 50 per cent in excess of requirements, and the domestic production of protein was just large enough to cover the need. It seemed also apparent from the data that the fat consumption in peace-time was too large, and that the fat of domestic origin should be enough to satisfy normal requirements. Consequently, it appeared evident to the German scientists, at any rate, that if the German people would reduce their consumption to the plane of physiological needs, that is, physiological needs chiefly computed by means of laboratory experiments, and maintain the domestic production on the peace-time basis, they would not experience much harm by a blockade.

When one compares what has been achieved in production with what the commission of German scientists believed could be attained, the results are not creditable to the agricultural classes, even when the influences of unfavorable weather are fully allowed for. The Eltzbacher Commission made the following estimates: (*a*) *peace-time use:* protein, 2,261,000 tons, and calories, 88,694,000,000,000, including protein of domestic origin, 1,650,000 tons, and calories, 71,282,000,000,000. (*b*) *physiological need:* protein, 1,605,000 tons; calories, 56,750,000,000,000. (*c*) *attainable production under blockade:* protein, 2,022,000 tons; calories, 81,250,000,000,000. Actual production in 1914-15 in foodstuffs

was: protein, 1,510,000 tons; calories, 63,410,000,000,000. Actual production in 1915-16 was: protein, 1,100,000 tons; calories, 57,000,000,-000,000.

The dietary of the industrial classes of Germany was from March to September, 1916, reduced to the physiological minimum. This diet was low in animal protein, very low in fat, and low in calories, and when the work that had to be done was considered, manifestly insufficient. A survey of the chief manufacturing cities of the empire carried out during the late months of 1916 indicated that the average intake for adults varied from 1.6 to 2 ounces of protein and from 1,800 to 2,500 calories per day. As Taylor remarked, since this was not sufficient to maintain the physical labor that was being done, this was accomplished by utilization of the body fat of the workers.

Food Situation in Great Britain.—It was not until the early part of the year 1917 that the British Government took any very definite steps leading to a control of the food supply, though a ban had been placed on some articles of food and, of course, advice had been given as to the need for economy of food and warning against waste had been freely tendered. The report on the food supply of the United Kingdom, drawn up by a committee of the Royal Society, was published in the first week of February, 1917, and provided some very interesting information. The first part contained an estimate of the annual food supply of Great Britain, imported and home-produced, in the period before the war, 1909-1913.

It may be said here that, according to Taylor(2), in the year before the war, about 13,750,000 tons of foodstuffs and feeding stuffs were imported into the United Kingdom, nearly ten millions of which were foodstuffs. It was not possible to give more than approximate figures, since there was overlapping, as, for example, between food fat and industrial fat. The total food consumption for Great Britain was probably about twenty million tons. To make the gross figure for importation of foodstuff more concrete, it may be stated that in 1914 the importation per capita was: wheat, 250 pounds; flour, 23.9 pounds; potatoes, 8 pounds; sugar, 80 pounds; rice, 14.2 pounds; ham and bacon, 14.2 pounds; beef, 20 pounds; mutton, 12.4 pounds; other meats, 8.4 pounds; butter, 9.46 pounds; cheese, 5.75 pounds, and eggs, 46 per head.

To turn again to the Committee's report, it is there stated that, after consideration of the dietary requirements of a nation for the most part engaged in active work, the Committee was convinced that they could not be met satisfactorily on a less supply in the food than 100 grams protein, 100 grams fat, and 500 grams carbohydrates, yielding approximately

3,400 calories per man per day, a "man" being an average workman doing an average day's work. The Committee adopted this as the minimum standard. Generally speaking, a woman or child requires less food than a man, and to convert the population of men, women and children into units, or "men," as defined above, the total number must be reduced by 23 per cent. In reckoning diet, 100 men, women and children equal 77 units, that is to say, men.

The total quantities of foodstuffs available during the period 1909-13 provided 4,009 calories per "man." There had been a certain margin, and the Committee calculated, taking the minimum physiological standard mentioned above, that there had been either wasted, or consumed in excess of requirements, of proteins 11 to 14 per cent, of fats 25 to 30 per cent, of carbohydrates 10 to 14 per cent. It should be noted that the figures for quantities of food are for weights as purchased, no attempt having been made for loss during distribution, nor for digestibility.

The second part of the report dealt with the food supply in 1916. The Committee stated that down to the end of July in that year, the supply of food had provided a general margin of about 5 per cent above the minimum necessary for proper nutrition and rather more as regards the supply of energy, so that a reduction to this extent would still furnish amounts of the essential food constituents conforming to the standard adopted. Such a reduction could be borne without serious injury to the community, provided steps were taken to ensure the equitable distribution of the available food throughout the population. Speaking as physiologists, the members of the Committee laid stress on the fact that in buying food the laboring population was buying energy. If rising prices curtailed for any class of the community its accustomed supply of food, its output of work would of necessity be reduced, and it was important to remember that a slight reduction of food below the necessary amount caused a large diminution in the working efficiency of the individual.

In an appendix to the report, some particulars were given of army rations. The weekly rations issued to the army at home in England were as follows: beef, 84 ounces; bacon, 14 ounces; bread, 112 ounces; sugar, 14 ounces, and in addition, the men were in the habit of purchasing various articles of food from a long list yielding on an average 1,510 calories a day, giving a total energy value for the diet of a man in the British home army of 4,031 calories a day. The civil population at a similar rate, but with a reduction of 23 per cent for women and children, would be entitled to a diet yielding an energy value of about 2,667 calories a day.

The following are figures estimating the food consumption of Great Britain during the first year of the war compiled by a German statistician, Ballod, a British physiologist, Thompson, and Dr. Alonzo E. Taylor.

FOOD CONSUMPTION PER HEAD PER DAY IN UNITED KINGDOM

	Protein	Fat	Carbohydrate	Calories
Thompson............	2.70 oz.	3.60 oz.	15.5 oz.	3,100
Ballod...............	3.75 "	2.58 "	15.6 "	2,900
Taylor................	3.25 "	3.18 "	15.1 "	3,000

According to Thompson for Great Britain, and the Eltzbacher Commission for Germany, the subsistence of one hundred inhabitants would be about covered by the food required by seventy-five adult males, and the man rations of the three estimations would be as follows, in ounces and calories:

FOOD REQUIRED

	Protein	Fat	Carbohydrate	Calories
Thompson............	3.59	4.81	20.7	4,130
Ballod................	5.0	3.45	20.8	3,860
Taylor................	4.38	4.24	20.1	4,000

The caloric need of the adult man was put by the Eltzbacher Commission at 3,000 calories, somewhat low for the extraordinary work of war time, lower by 400 calories than that set as a minimum by the Committee of the Royal Society of Great Britain. However, reckoning it at this figure, 40,240,000,000,000 calories would be required to maintain the bodily heat and energy of the 45,370,000 inhabitants of the British Isles for a year.

The protein requirements calculated in similar fashion, on the computation of the Eltzbacher Commission, 80 grams per day for an adult man, would work out at 1,130,000 metric tons. The British Committee considered that the minimum protein requirement for an adult man was 100 grams, while Chittenden and other physiologists have contended that this amount could be greatly reduced without injury to the public health. The German experience during the war seems to lend some support to the view that Chittenden and his followers were correct, but until more is

known concerning conditions in Germany than is known at the time of writing, it will not be discreet to be dogmatic on this point. There is little doubt that the Germans concealed the true state of affairs to a large extent. Probably much more food was imported than was believed, and also it is not unlikely that the condition of their industrial classes was worse than it was credited to have been. Little bad news was allowed to leak out, and it must be borne in mind that the main—almost sole—object of the German rulers was to feed their army and workers directly connected with military supplies and to pay much less attention to the other members of the community. The fact must also be taken into consideration with respect to protein ingestion that the British have always been heavy meat eaters, and that inherited and ingrained habits count for a good deal when the nutritive value of a diet is concerned.

Nevertheless, we will take it for granted that the British consumption of protein was larger than physiological requirements. Taking the physiological requirements of protein daily for an adult man at eighty grams a day and the caloric need at 3,000 calories, the amount of waste in a year would read somewhat as follows:

	Protein Tons	Billion Calories
Consumption..........	1,660,000	53,900
Need.................	1,130,000	40,240
Waste................	530,000	13,660

According to the Eltzbacher Commission, the waste of the German people was: protein, 650,000 tons, and calories, 31,899,000,000,000. The per capita waste was thus greater in protein in Great Britain, greater in calories in Germany.

From all available data, one might adjudge seven hundred thousand tons as a reasonable figure for domestic production of protein in Great Britain. This leaves a deficit of nearly 500,000 tons. In other words, the domestic production of protein was about 55 per cent of the requirements. According to Taylor's estimate, the following figures show approximately the situation in Great Britain in the early part of 1917 as regards protein and calories:

	Protein Tons	Billion Calories
Consumption..........	1,660,000	53,900
Requirements.........	1,130,000	40,240
Domestic production...	700,000	19,000
Deficit................	430,000	21,240

In Taylor's papers on the food situation in Germany, which have been largely employed as a basis for this chapter, the lack of sugar was referred to and attention was drawn to the fact that saccharin was used as a substitute. In a report which the same author wrote for the American Embassy at Berlin, he gave a detailed analysis of the food of the civil prisoners at Ruhleben Camp. But before giving a part of this report and the references therein to saccharin, a few comments will be made on the feeding of military prisoners. The ration established for military prisoners in Germany in the month of June, 1916, contained 2,700 calories a day, made up of 80 grams of protein, 29 of fat, and 500 of carbohydrate. This, though not plentiful, was adequate as regards its caloric value for average men not doing much muscular work. The proportion of fat is low, but such a diet need not endanger nutrition in adults, provided the requisite food value is made up by other foodstuffs. The diet, however, for certain prisoners at Ruhleben Camp, and concerning which Taylor wrote, was indeed sparse—in fact, a starvation diet. In the following table the Ruhleben diets are compared with ordinary standards of living:

RUHLEBEN DIETS COMPARED WITH STANDARD DIETARIES

	Calories	Protein	Fat	Carbohydrate
English laborer	3,655	184	71	570
German farm laborer (Ranke)	4,696	143	108	788
Standard diet for a man of moderate activity	2,820	100	100	360
Military prisoners of war in Germany	2,700	80	29	500
Ruhleben diet before reduction	1,580	59	12	308
Diet actually taken when increased by food left by other prisoners	2,725	98	24	523
Ruhleben diet since reduction	1,220	39	6	255
Reduced diet when increased by food left by others	1,930	55	10	410

The substitution of saccharin for sugar in the diet of the Ruhleben prisoners was commented upon in the *Journal of the American Medical Association,* Aug. 12, 1916, as a war food abuse. When sugar became scarce in Germany, the law prohibiting the use of saccharin was abrogated. Two months later its use was made compulsory in certain directions. However, as Taylor points out, saccharin can never be termed a substitute for sugar from the gustatory or any other point of view. Certain articles of food containing saccharin have the normal taste; to other

articles of food, however, an abnormal after-taste is given, a condition particularly noticeable in beer.

Before food regulation was introduced into Great Britain, the diet of the munition workers had been regulated with surprisingly good results. It must be borne in mind that an immense army of such workers, a large proportion of whom were women and children of over twelve years of age, had been organized. It was incumbent on the state from every point of view that their health should be carefully safeguarded, and naturally a sufficiently nutritious diet was a *sine qua non* in the achievement of this object. The soldier and the sailor expected that their diet would be arranged to meet their particular needs, and when the great rise in the price of food occurred, it was found that, in order to supply the munition workers with food of a character calculated to enable them to fulfill their important duties with efficiency, they must be dieted according to their special requirements.

Dr. Leonard Hill was chosen to make an investigation into the matter, so that he might supply data upon which improvements in diet might be based. He laid down the principle that the amount of food taken should be regulated solely by the loss of energy it was required to replace, and pointed out that fortunately the chief foodstuffs really provided all the nourishment that was requisite for and consistent with health, better probably than the more highly flavored and expensive foods which artificially stimulate the appetite. Of such foods, Dr. Hill gave the following list: bread, margarin, porridge, milk, herrings, cheese, beans, cabbages, oranges, and the cheaper kinds of meats.

Under his direction the canteen meals for munition workers who came from some distance were analyzed after the following method: The ingredients were all thoroughly mixed, after weighing each separately, so that dietaries could afterwards be constructed from the weights. An aliquot part of the intimate mixture was thoroughly dried and weighed. In the dry material protein was determined from a nitrogen estimation, the fat by ether extractions in a Soxhlet's apparatus, the ash by burning and weighing, and the carbohydrate by difference. In this way the amounts of dry protein, fat and carbohydrate respectively in the meal were obtained, and from these the caloric value was determined. An analysis of twelve canteen meals showed that they afforded on an average, protein, 42.43; fat, 36.7; carbohydrate, 146.9 grams, yielding 1,114 calories per capita. The average canteen dinner was found to be good, containing an energy value of 1,114 calories well distributed among the amounts of protein, fat and carbohydrate.

The meals brought from home by the workers were also submitted to analysis. The workers whose meals were thus obtained were not asked beforehand to bring a sample meal, but were interrogated at the entrance gates and asked to exchange the contents of their basket for a sum ample to buy a meal at the canteen. In the case of men, these meals were found to be adequate, but in the case of girls there was a very wide variation, from 300 up to 1,100 calories. As for the latter, the breakfast meal before starting work was often found to consist of white bread and boiled tea. Although there was nothing in the investigation which was very new, it showed that a valuable degree of practical certainty was being reached in regard to the minimum adequate diet required for a certain type of manual labor.

The following table(3) may be of interest as showing the diet during the war, but before voluntary restriction, of three middle class families in England. The families consisted of 16 persons, 3 men (sedentary), 9 women and 4 children:

DIETARIES FOR THREE MIDDLE-CLASS FAMILIES, SIXTEEN PERSONS, IN ENGLAND BEFORE VOLUNTARY RESTRICTION

	Weekly Weight in Ounces	Daily Yield in Grams			Energy Value in Calories
		Protein	Fat	Carbohydrate	
Meat, sausages, bacon	50.5	28.8	52.4	1.1	663
Bread	58.0	18.7	2.8	123.1	580
Sugar	8.9	....	....	36.3	145
Total	117.4	47.5	55.2	159.5	1,388
Cheese	4.0	4.5	4.9	0.4	63.4
Butter, etc.	13.2	0.5	43.3	....	424.0
Potatoes	32.0	2.27	0.13	27.2	122.0
Flour and Oatmeal	7.0	16.2	2.3	21.3	103.0
Rice, lentils, etc.	11.6	1.6	0.7	24.3	270.0
Jam and dried fruits	3.8	3.7	0.2	8.7	37.8
Total	71.6	28.77	53.53	81.9	1,020.2

Total ration of restricted articles	47.5	55.53	159.5	1,388
Total of extras	28.77	53.53	81.9	1,020.2
	76.27	108.73	241.4	2,408.2

So far as this examination went, it appeared to show that the members of middle-class families in England during the war, when left to their own devices, received rather less protein, somewhat more fat, and considerably less carbohydrates than the standard per head of the whole population, and that the yield in calories was about 15 per cent less, waste not being reckoned.

From the above table, the average weekly consumption of milk was omitted. This reached the amount for the three families of 4.8 pints per week, or 0.7 pints a head, bringing up the energy value of the diet per capita per day to 2,910.

Voluntary Rationing Scheme in Great Britain.—A voluntary rationing scheme had been initiated in Great Britain, and was favorably commented upon in an editorial which appeared in the *Lancet,* November 17, 1917. It was pointed out that while a faithful adherence to the limited amounts of the staple foods outlined in the scheme would save a grave situation, no hard dietetic or physiological sacrifice was called for. The staple foods named were bread, flour and other cereals, meal, butter, margarin, lard and sugar. Outside this list no rationing was suggested. Potatoes were not included and therefore, as a valuable carbohydrate supply, might be largely employed to eke out the stock of scheduled foodstuffs, and so save the staples. In addition an exchange could be made in certain cases, notably with regard to bread and meat. Thus any person might take half a pound of meat over and above his meat ration in exchange for half a pound of bread to be deducted from his bread ration and vice versa. The *Lancet* thought that the scheme bears evidence of being well thought out from the economic point of view, while it provided a physiological sufficiency for all. The public of the United States would do well to bear this in mind, for it is important to remember that a voluntary rationing scheme which provides amply for all physiological needs is much less a hardship than actual famine, while its adoption means the releasing of so much tonnage, and adding to the efficiency of transport service. In plain words, the individual who loyally enters into the spirit of the scheme will be helping to win the war, and is doing so in contradiction to no law of physiology or of medicine.

The English scheme applies with force to the food situation in America. The people must coöperate in thrift so far as food is concerned and especially with respect to the staple foods. However, the food situation in the United States will be dealt with at some length further on.

The following table gives at a glance the new rations proposed in Great Britain in November, 1917:

ADULT RATIONS IN GREAT BRITAIN, PER HEAD PER WEEK

Occupations	Bread	Other Cereals, Oz.	Butter, Fats, Margarine, Lard, Oil, Oz.	Meat, lb.	Sugar, oz.
1. Men on very heavy industrial or on agricultural work.....	8 lb. 0 oz.	12	10	2.0	8
2. Men on ordinary industrial or other manual work.........	7 " 0 "				
3. Men unoccupied or on sedentary work	4 " 0 "				
4. Women on heavy industrial work or on agricultural work	5 " 0 "				
5. Women on ordinary industrial work or in domestic work..	4 " 0 "				
6. Women unoccupied or on sedentary work...............	3 " 0 "				

The bread rations included all flour, whether used for bread or for cooking. Flour might be taken instead of bread at the rate of ¾ lb. of flour for every pound of bread.

The other cereal rations included oatmeal, rice, tapioca, sago, barley meal, corn flour, maize meal, dried peas, beans and lentils, and all cereal products except bread and flour. The weight given was the weight of the dry article, as bought. If the full bread ration was not used, the amount saved could be taken in other cereals. The "meat" rations included the average amount of bone, which might be taken as one quarter of the weight of the actual meat. Any parts of meat, such as rump steak, bacon or suet, which were bought without bone, must count for one-quarter more than their actual weight. On the other hand, any bone in excess of a quarter of the actual meat bought might be deducted. Poultry and rabbits might be counted at half their actual weight. The meat rations included suet.

Sir Arthur Yapp, who outlined the scheme, divided the population into six sections, three for men and three for women. Children were to receive their reasonable ration of essential foods, and as their needs differ so widely, a definite ration was omitted for them. Broadly, the scheme provided more bread but less meat and sugar.

A very pertinent table on the unrestricted diet of a sedentary worker was published by Dr. A. D. Waller, F.R.S. (4), a well-known physiologist and the author of a standard text-book on physiology. The following table gives the constituent parts of Dr. Waller's meals on three successive days, and it will be gathered from this table that his average caloric consump-

tion for the three days was 2,471, inclusive of 227 calories of claret and whiskey, of which the caloric value is not undisputed. Of the total 2,471, breadstuffs constituted 840 calories, which is equivalent to 334 grams of breadstuffs; of the 334 grams of breadstuffs, 200 grams were loaf bread and 134 grams were puddings, etc.; 100 parts of his bread material, therefore, were made up of 60 parts of loaf bread and 40 parts of other farinaceous materials.

THE UNRESTRICTED DIET OF A SEDENTARY WORKER

OCTOBER 3RD, 1916

1. EARLY TEA

c/o assumed									
Protein	Fat	Carbohydrate		Grams	Protein	Fat	Carbohydrate	Calories	
8	1	50	Bread..............	20	1.6	0.2	10.0	49.42	
1	80	...	Butter..............	5	0.05	4.0	....	37.405	
3.5	4	5	Milk..............	20	0.7	0.8	1.0	14.41	
...	...	100	Sugar..............	10	....	....	10.0	41.0	
					2.35	5.0	11.0	142.235	

2. BREAKFAST

Protein	Fat	Carbohydrate		Grams	Protein	Fat	Carbohydrate	Calories	
8	1	50	Bread..............	75	6.0	0.75	37.5	185.325	
1	80	...	Butter..............	30	0.3	24.0	....	224.43	
3.5	4	5	Milk..............	300	10.5	12.0	15.0	216.15	
10	50	...	Bacon..............	20	2.0	10.0	....	101.20	
12	12	...	Egg..............	50	6.0	6.0	....	.....	
...	...	100	Sugar..............	25	....	....	25.0	102.50	
0.5	0.1	50	Marmalade........	50	0.25	0.5	25.0	103.99	
					25.05	52.8	102 5	1,013.995	

3. LUNCH

Protein	Fat	Carbohydrate		Grams	Protein	Fat	Carbohydrate	Calories	
8	1	50	Bread..............	60	4.8	0.6	30.0	148.26	
1	80	...	Butter..............	15	0.15	12.0	....	112.215	
15	5	...	Meat..............	25	3.75	1.25	....	27.0	
25	25	2.5	Cheese..............	15	3.75	3.75	0.375	51.7875	
...	...	100	Sugar..............	10	....	....	10.0	41.0	
5% Alc.			Wine..............	(150)	....	....	....	....	(52.5 cals.)
					12.45	17.6	40.375	380.262	

4. AFTERNOON TEA

NIL.

5. DINNER

Protein	Fat	Carbohydrate		Grams	Protein	Fat	Carbohydrate	Calories	
2	2	6	Soup..............	150	3.0	3.0	9.0	77.1	
10	2	...	Fish..............	40	4.0	0.8	....	23.84	
15	5	...	Meat..............	60	9.0	3.0	....	64.8	
8	1	50	Bread..............	30	2.4	0.3	15.0	74.13	
2	2	40	Pudding..............	50	1.0	1.0	20.0	95.4	
2	0.1	20	Potatoes..............	50	1.0	0.05	10.0	45.565	
1	80	...	Butter..............	5	0.05	4.0	....	37.405	
25	25	2.5	Cheese..............	10	2.5	2.5	0.25	34.525	
10	1.0	85	Biscuits..............	25	2.5	0.25	21.25	99.7	
5% Alc.			Wine..............	(300)	....	....	....	.....	(105 cals.)
...	...	100	Sugar..............	15	....	....	15.0	61.5	
					25.45	14.9	90.5	613.965	

6. SUPPER

Protein	Fat	Carbohydrate		Grams	Protein	Fat	Carbohydrate	Calories	
50% Alc.			Whiskey..........	(30)	....	....	....	.....	(105 cals.)
10	1	85	Biscuits..........	25	2.5	0.25	21.25	99.7	
					2.5	0.25	21.25	99.7	
			Total..........		67.8	99.55	280.625	2,270.657	+Total (262.5)
			Total calories	......	....	....	....	2,533.157	

THE UNRESTRICTED DIET OF A SEDENTARY WORKER—*Continued*

OCTOBER 4TH, 1916

1. EARLY TEA

c/o assumed									
Protein	Fat	Carbohydrate		Grams	Protein	Fat	Carbohydrate	Calories	
8	1	50	Bread.............	20	1.6	0.2	10.0	49.42	
1	80	...	Butter.............	5	0.05	4.0	....	37.405	
3.5	4	5	Milk.............	20	0.7	0.8	1.0	14.41	
...	...	100	Sugar.............	10	....	....	10.0	41.0	
					2.35	5.0	21.0	142.235	

2. BREAKFAST

15	8	60	Porridge (20 dry)...	100	3.0	1.6	12.0	76.38	
8	1	50	Bread.............	60	4.8	0.6	30.0	148.26	
1	80	...	Butter.............	30	0.3	24.0	....	224.43	
3.5	4	5	Milk.............	400	14.0	16.0	20.0	288.20	
10	50	...	Bacon.............	20	2.0	10.0	....	101.20	
12	12	...	Egg.............	50	6.0	6.0	....	80.40	
0.5	0.1	50	Marmalade.........	50	0.25	0.05	25.0	103.99	
..	...	100	Sugar.............	25	....	....	25.0	102.0	
					30.35	58.25	112.0	1,125.36	

3. LUNCH

8	1	50	Bread.............	45	3.6	0.45	22.5	111.195	
1	80	...	Butter.............	10	0.1	8.0	....	74.81	
10	2	...	Fish.............	60	6.0	1.2	....	35.76	
2	2	40	Pudding...........	60	1.2	1.2	24.0	114.48	
5% Alc.			Wine.............	(150)	....	....	....	.....	(52.5 cals.)
					10.9	10.85	46.5	336.245	

4. AFTERNOON TEA

8	1	50	Bread.............	40	3.2	0.4	20.0	98.84	
1	80	...	Butter.............	10	0.1	8.0	....	74.81	
...	...	100	Sugar.............	5	....	....	5.0	20.50	
3.5	4	5	Milk.............	10	0.35	0.4	0.5	7.205	
					3.65	8.8	25.5	201.355	

5. DINNER

15	5	...	Meat.............	40	6.0	2.0	....	43.2	
8	1	50	Bread.............	45	3.6	0.45	22.5	111.195	
2	2	40	Pudding...........	80	1.6	1.6	32	152.640	
2	0.1	20	Potatoes...........	80	1.6	0.08	16	72.904	
1	80	...	Butter.............	5	0.05	4.0	....	37.405	
25	25	2.5	Cheese.............	10	2.5	2.5	0.25	34.525	
10	1	85	Biscuits.............	12.5	1.25	0.125	10.625	49.850	
...	...	100	Sugar.............	5	....	....	5.0	20.500	
5% Alc.			Wine.............	(100)	....	....	....	.....	(35 cals.)
					16.6	10.755	86.375	522.219	

6. SUPPER

8	1	50	Bread.............	15	1.2	0.15	7.5	37.065	
25	25	2.5	Cheese.............	20	5.0	5.0	0.5	69.050	
50% Alc			Whiskey...........	(30)	....	....	....	.....	(105 cals.)
					6.2	5.15	8.0	106.115	
					70.05	98.805	299.375	2,433.529	+(192.5)
			Total calories =	......	....	....	....	2,626.029	

THE UNRESTRICTED DIET OF A SEDENTARY WORKER—*Continued*

October 5th, 1916

c/o assumed									
Protein	Fat	Carbo-hydrate		Grams	Protein	Fat	Carbo-hydrate	Calories	
			1. Early Tea						
8	1	50	Bread	30	2.4	0.3	15.0	74.13	
1	80	...	Butter	5	0.05	4.0	....	37.405	
3.5	4	5	Milk	30	1.05	1.2	1.5	21.615	
...	...	100	Sugar	5	....	....	5.0	20.5	
					3.5	5.5	21.5	153.65	
			2. Breakfast						
15	8	60	Porridge (20 dry)	100	3.0	1.6	12.0	76.38	
8	1	50	Bread	60	4.8	0.6	30.0	148.26	
1	80	...	Butter	15	0.15	12.0	....	112.215	
3.5	4	5	Milk	400	14.0	16.0	20.0	288.2	
10	2	...	Fish	65	6.5	1.3	....	38.74	
...	...	100	Sugar	10	....	....	10.0	41.0	
0.5	0.1	50	Marmalade	50	0.25	0.5	25.0	103.99	
					28.7	31.55	97.0	808.785	
			3. Lunch						
8	1	50	Bread	40	3.2	0.4	20.0	98.84	
15	5	...	Meat	30	4.5	1.5	....	32.4	
2	0.1	20	Potatoes	30	0.6	0.03	6.0	27.339	
1	80	...	Butter	5	0.05	4.0	....	37.405	
5% Alc.			Wine	(150)	....	....	....	.....	(52.5 cals.
					8.35	5.93	26.0	195.984	
			4. Afternoon Tea						
3.5	4	5	Milk	15	0.525	0.6	0.75	10.8075	
...	...	100	Sugar	5	....	......	5.0	20.5	
					0.525	0.6	5.75	31.3075	
			5. Dinner						
2	2	6	Soup	200	4.0	4.0	12.0	102.8	
15	5	...	Meat	85	12.75	4.25	....	91.8	
8	1	50	Bread	60	4.8	0.6	30.0	148.26	
2	0.1	20	Potatoes	60	1.2	0.06	12.0	54.678	
2	2	40	Pudding	80	1.6	1.6	32.0	152.64	
25	25	2.5	Cheese	15	3.75	3.75	0.375	51.7875	
1	80	...	Butter	10	0.1	8.0	....	74.81	
0.5	0.1	50	Jam	20	0.1	0.02	10.0	41.596	
5% Alc.			Wine	(200)	....	....	....	.....	(70 cals.)
					28.3	22.28	96.375	718.3715	
			6. Supper						
50% Alc			Whiskey	(30)	....	....	....	.....	(105 cals.)
10	1	85	Biscuits	30	3.0	0.3	25.5	119.64	
			Total		72.375	66.16	272.125	2,027.738	+(227.5 cals.)
			Total calories =					2,255.238	

Summary

	Protein	Fat	Carbohydrates	Calories	Calories (Alc.)
October 3rd	67.8	90.55	280.625	2,270.657	262.5
October 4th	70.05	98.805	299.375	2,433.529	192.5
October 5th	72.375	66.16	272.125	2,027.738	227.5
Total for 3 days	210.225	255.515	852.125	6,731.924	682.5
Average for 1 day	70.075	85.1717	284.0417	2,243.975	227.5
				2,471.475	

Of course, Dr. Waller's case was not representative. He was 60 years of age, weighed 190 pounds, and belonged to the class of sedentary workers whose caloric requirements are considerably lower than those of the manual worker. Still it is a matter for some surprise that his calories should be as low as 2,244. It is interesting to note that Waller in his "Text-book of Physiology" has given 3,000 as the average calorie requirement per working man per day for food as eaten, and that this should have as its foundation 1 pound of bread per day.

USE OF CERTAIN FOODSTUFFS IN WAR

Bread and Cereal Foods.—With regard to the value of bread as a staple diet, it is instructive to note that the ordinary prison diet in an English jail, adopted in 1889, contains 3,040 calories, of which the bread, inclusive of flour and oatmeal, amounts to 2,378 calories, of which 1,715 calories are afforded by 22 ounces per day of actual bread. On this diet it was found that 82 per cent of the prisoners gained weight, while 18 per cent lost weight. This brings us to the question of bread and its value as a food.

One of the most valuable, perhaps the most valuable, lesson that the war has taught us, or rather has emphasized, is that highly milled bread is less nutritious than whole-meal bread. It is now known that the consumption of cereals from which the husks have been removed, when used as a sole or main means of nutriment, is responsible for disease.[1] Beri-beri, pellagra, scurvy and probably rickets have all been traced more or less to this cause. Bread made from highly milled flour when constituting but a part of the diet, is not directly responsible for diseased conditions, but from the outlook of health is not to be recommended. It tends to constipation, because it requires little mastication and also requires little exercise by the organs of digestion; it is smooth and does not irritate the digestive organs, or induce internal secretions to exertion, and consequently it is apt to take an undue time for assimilation and absorption, and for its waste products to pass through the intestinal tract. Moreover, according to the most recent views, the very part of the cereal that is milled or taken away is that which contains food elements which are indispensable for growth and the maintenance of life. These have been termed "accessory diet factors" or "vitamines." They may be conceived of as stimulating certain physiological processes and as essential to certain functions.

[1] See also Volume II, Chapter VIII; Volume III, Chapter XVII.

As Mendel(5) has pointed out, the lubricant is quite as important to a machine as the energy-furnishing fuel. In a similar way these diet accessories or "vitamines" may possess peculiar usefulness. Some of them are believed to be easily impaired by heat; in the language of the chemist, they may be thermolabile. Hence the use of heat for preserving or sterilizing foods suggests new difficulties. They may be lost in the wastes of the modern technical processes, as in the milling of cereals. Wheat, for example, by modern milling is denuded of its pericarp. A beautifully smooth white flour results which has been deprived of a considerable amount of its nutritive virtues and is hardly suitable as food for a human being, supplied with a strong jaw and teeth intended to be employed in mastication.

The food orders in Great Britain, promulgated chiefly with the view of economizing food, although, of course, distasteful to the mass of the population, have proved with regard to the preparation of bread, a blessing in disguise. Bread in all countries, and in Great Britain in particular, is the chief means of sustenance of the working classes, and it is somewhat curious that the necessities of war should have brought into force a measure which, regarded from the public health standpoint, is as important as any measures which have been brought forward in modern times. Wheat, of all the cereals used for the manufacture of bread, is, perhaps, the most nutritious. At any rate, it has the most delicate flavor, it contains a large amount of gluten, and for making bread is, on the whole, the most popular product of the earth. In addition, wheaten flour, unlike the flour of other cereals, is readily kneadable, and can therefore be made into bread, macaroni, vermicelli, pastry, and all kinds of puddings and cakes.

The first food orders issued in England called for the extraction of 76 per cent from the total grain; a few weeks later the extraction of a further 5 per cent was ordered; and it may be said that, after the early summer of 1917, the wheaten bread consumed in Great Britain was to all intents and purposes whole-grain bread. An option, however, was given to millers to mix with the wheat, flour derived from barley, maize, rice or oats, to the extent of 10 per cent. This meant that the miller need not mill his wheat further than the original allowance of 76 per cent, provided he added a proportion of other flours. It is possible to add to flours rich in gluten a proportion of starch, as for example, flour made from corn, without materially reducing the nitrogen value when compared with a low-grade wheaten flour. The energy value of a loaf from such flour would be quite high, while its nourishing properties would be little

impaired. Corn flour and rice, however, would somewhat detract from its protein value, while barley and oats would add proteins and fat. The loaf containing an addition of barley and oats would, from a dietetic point of view, likely enough, have a superior value to the loaf made with a similar proportion of corn or rice.

To those who hold that bread is primarily eaten not so much as a source of protein, but as an easily digestible, attractive form of starch, it matters little which flour is employed. Obviously, however, in war time, the question of cost is predominant and the wheat substitutes can be used for no good purpose unless they are cheaper than wheat flour itself. It may be pointed out that in America, from this standpoint, corn particularly commends itself as a food. Apart from this point, the physical qualities of a loaf of bread must be considered, texture for one thing being an important property. The characteristics which formerly chiefly commended a loaf of wheaten bread were that it was light and spongy, easily masticated and digestible. It goes without saying that the lumpy, sodden loaf is unattractive and indigestible, and its food value may be largely discounted owing to its causing gastric troubles. On the other hand, while a loaf should be light, it is an advantage that it should be so baked that externally it is hard and crusty, affording plenty of work for the jaws, teeth and salivary glands.

Nearly all the vegetable foods which invite mastication are crusty bread, dry toast, hard biscuits, salads, nuts and apples. Our staple vegetable food—wheaten bread—is almost invariably eaten in a spongy form. The loaves are shaped so as to afford a minimum of surface for crust, and are lightly baked so that the crust shall be as thin as possible. In fact, the prejudice that the majority of people have against crust is such that the most crusty loaves, those which have rested on the floor and against the sides of the oven, fetch a lower price than the others.

The more thoroughly a farinaceous food, as bread, is chewed, the more intimately will it be mixed with the saliva, and the more efficiently is it likely to be digested. It is certain, furthermore, that when food is well digested, it will go further, and less of it will be required than when it is not well digested. Thus, a piece of crusty bread well masticated will go a longer way to satisfy the appetite and the nutritive requirements of the system than an equivalent of pudding or of some of the soft mushy food which has such a vogue in this country. While by no means a disciple of Fletcher, who unduly exalts the merits of mastication, and who advocates its practice to absurd lengths, the author is convinced that it would be in the best interests of the health of the community at large if

more mastication were practiced, particularly with regard to the carbohydrates—in short, if less soft food were eaten.

The best way to secure adequate mastication is to select foods which invite or even compel it. It is chiefly in regard to wheaten flour, oatmeal and rice that reform is most needed. Many people in England, at the time of writing, are wondering, now that war bread has made its appearance, why they ever preferred the bread made from highly milled flour. The ideal loaf of wheaten bread from the nutritive standpoint is the crusty one made from whole-meal, which needs more mastication than the spongy loaf, promotes good digestion, excites peristaltic action, and, above all, contains those food elements known as vitamines, which stimulate certain physiological processes and are essential to the perfect well-being of the organism as a whole.

Of other cereal foods than wheat, oats in the form of oatmeal, corn and rice occupy the first places. From the aspect of protein value, oatmeal is the most nutritious, containing as it does more protein than wheat and considerably more fat. Rice is less nutritious than wheat or oats, and inasmuch as it is polished rice which is imported, and which, eaten solely, constitutes the deficiency diet *par excellence,* its employment as a staple of diet is not indicated.

With regard to oatmeal as a war food, it may be recommended both on the grounds of economy and nutritive properties. It is in itself a valuable food, but in the form of porridge does not conduce to mastication. Moreover, the oatmeal flour sold nowadays is made from oats which have been denuded of their husks, and is, when made into porridge, an especially soft and pappy article of diet. The good, coarse Scotch oatmeal porridge of yore, which required a certain amount of mastication, and which contained the husks of grain in which were the vitamines, is no longer seen in this country. In its place is offered a smooth bland substance, wholly devoid of the irritating, health-giving elements referred to and affording not the slightest exercise to the jaws, teeth or the salivary glands. From the point of view of mastication, oatmeal biscuits are preferable to oatmeal porridge, but the latter is so popular and valuable a food that it may be permitted in war time with the proviso that it is made from whole-meal and that it is subjected to some sort of chewing.

While the good influence of protein consumption on health may have been exaggerated, and while the need for a large protein intake may have been overestimated, it is still allowed on all hands that a certain amount of protein is necessary for the maintenance of the bodily powers at a high standard. Many even hold that a considerable protein intake is benefi-

cial, and the author is one of these. It must be remembered that the protein molecule is composed of a group of dissimilar chemical units, many of which appear to be indispensable for the nutritive functions. As the animal body cannot construct all of these synthetically, it is dependent for a supply thereof upon the diet. The proteins of foods commonly eaten provide these essential units in unlike yields. Accordingly, the view is gaining ground that an adequate ration must furnish these units in amounts sufficient quantitatively and qualitatively.

Corn possesses satisfactory nutritive properties in many directions, but is somewhat lacking in its protein contents, or perhaps it would be more correct to say that corn and the by-products of the corn kernel are considered as a result of laboratory analysis, inadequate for good feeding purposes unless they are supplemented by other protein-containing food. It has been suggested by scientific authorities that the addition of supplementary proteins—perhaps those which are present in dried milk products—might render such a food as corn, which in this country is plentiful and inexpensive, but to some extent possibly inefficient from the protein standpoint, considerably more valuable as a staple article of diet. By many it is argued, however, that the slight lack of protein in corn, compared with wheat and oats, detracts little if any from its nutritive value. Practical experience has demonstrated that it is a wholesome food, and, after all, it is experience that is, taking everything into consideration, the surest guide.

According to Dr. Haven Emerson, Health Commissioner of New York, corn meal afforded the same amount of nourishment as wheat flour and was, at any rate, in April, 1917, 25 per cent cheaper. No doubt, from several points of view this statement is correct, and corn meal is a nourishing form of food and one considered from the outlook of food economies in war time, to be advocated as a staple diet. Yet, as in the case of wheat, oats and rice, in fact of all cereals, corn deprived of its husks is a less nutritive aliment by far than when these are allowed to remain. More than a strong suspicion has been aroused, approaching indeed conviction, by the researches of Voegtlin and others, that pellagra is a deficiency disease, and that its prevalence in the Southern States is largely if not entirely owing to the manner in which corn, which is the staple diet of the population, is milled. It is, then, as obvious in the instance of corn as in that of rice, wheat, oats and other cereals, that it should not be highly milled in order to obtain the greatest nutritive benefit from its consumption. The war has taught and emphasized the point that all cereals regarded from the health and economical aspects

should be so milled or prepared for human consumption that the coarser parts should be left for reasons which have been fully explained in different portions of this work.

A great advantage possessed by corn as a food is that it is pleasant to the palate and that it may be cooked and prepared in a variety of ways, while above all it is cheap. Our readers may be reminded of the fact that during the Civil War soldiers subsisted for considerable periods of time almost wholly upon corn, employing it even as a vehicle for making a substitute for coffee.

Potatoes.—It is hardly necessary to dwell upon the fact that potatoes are factors of much importance in war-time feeding. A bountiful potato crop probably saved Germany at a very critical period. Potatoes, however, do not provide such reliable crops as the cereals, and if a potato crop fails, it usually fails wholly. It may be pointed out that, as a rule, there is gross waste in the preparation of potatoes for food. There is no need—indeed, in war time, the custom should be strongly discountenanced if not prohibited—of peeling potatoes before cooking them. A useful part of the potato is removed with the skin, and the majority of people can eat potato skin with advantage. Special care should be taken not to waste the highly nutritious potato. Potato bread is a pleasant and satisfying food, and it is a good plan to make it of cooked potatoes which might otherwise be wasted.

Milk.—The question of milk is a very obtrusive one in war time. It has become almost an article of faith that a large supply of milk is indispensable to the maintenance of good health, and that, if a milk supply failed wholly or in part, the consequences would be disastrous. In time of war, foodstuffs and feeding materials must be economized. To find feeding material sufficient to maintain cows in such a condition that they will provide a good supply of milk, implies a great deal of labor and also the importation of an amount of feeding material which is inconvenient when not impossible under war conditions. It is assuredly true that to conserve infant life, a certain supply of cow's milk is necessary, that is, in the existing state of affairs, when so many women do not suckle their offspring. But that, after the baby age is passed, milk is an absolutely essential article of diet is strongly combated by many authorities. Campbell(6) went so far as to declare that the child, as distinguished from the babe, does not need milk and would not suffer greatly if the supply of dairy milk suddenly failed. He argued, in the first place, that milk, affording as it does a peculiarly favorable soil for the growth of disease germs, has carried disease and death to hecatombs of children. It has

further acted injuriously by favoring the consumption of soft, pappy foods. It is obvious that the infant, like the young of other mammals, requires milk for the first period of its life, and that the proper milk for it is that of its own mother. When this source of supply fails or is not available, as so frequently occurs in these days, resort must be had to the milk of other animals, cows or goats. This has not proved an unmixed blessing, but the question has been so thoroughly covered in Volume II, Chapter XV, and Volume III, Chapter XXIV, that it would be superfluous to lay further stress on this phase of the matter.

According to Campbell, while the infant needs milk of some kind during the first nine or ten months of life, it does not need any after that period. Why should the young of man any more than the young of other mammals require milk after it has left the breast? It is only since man first domesticated the cow and goat—and this from the point of view of his evolution was but as yesterday—that he has been supplied with any milk other than human, and it is absurd to suppose that before that time his health suffered from the lack of cow's or goat's milk. The pre-agricultural tribes to this day are without any, and until civilized man deteriorated them by the introduction of alcohol and European vices, they were magnificent physical specimens of manhood.

The argument is not made that dairy milk is a useless food for man, but merely that it is not essential to him after the nursing period. Its chief value to the human race is as a source of butter and cheese, two highly concentrated and agreeable foods, admitting of prolonged storage, as not only cheese but salt butter may be kept for many months. Undoubtedly cheese is a very valuable form of food in war time, on account of the large amount of protein that it contains. The manufacture of milk into butter and cheese rather than its use in the form of milk, especially into cheese, is prompted by considerations of health and economy alike.

Sugar.—Another article of food which has given rise to violent and persistent discussion, and the use of which has been the most vexed question of all with regard to food economics in Great Britain and Germany, is sugar. In Germany sugar was consumed in immense quantities, mainly, perhaps, because that country produced it on the largest scale. Now so short is the supply there that, as noted previously, saccharin has been substituted. It was not long ago that sugar was lauded as an essential. Now neither scientific men nor practical observers speak so decidedly in favor of sugar as a necessary ingredient or part of a diet. Mendel says that, although sucrose, the form in which it is generally used, has a considerable fuel value in the organism, its dietary use is primarily

dictated by considerations of flavor. Opinions are occasionally divided as to the place of this sugar in the dietary. Mendel is of the opinion that the artificially colored white sugar has nothing except a false standard to recommend it in place of the natural cream-colored sugar. It will be observed that Mendel appears sceptical as to white sugar being of any great nutritive value, but does not comment on the cream-colored product.

Campbell, referred to above, propounded as iconoclastic opinions with regard to the food value of sugar as he propounded concerning milk. He stated that we could get on very well without sugar at all. Primitive man had none but the limited quantity furnished by wild honey. War prices are exorbitantly high, and it consequently behooves everyone to be economical. He maintained that all money spent on candy is worse than wasted, and recommended that none should be so spent, that the money saved in this way should be loaned to the state, and that the multitude of persons engaged in the sweet industry should be transferred to occupations more profitable to the country.

More than one well-known physiological authority has stated that sugar is not a natural food, inasmuch as the human economy is constructed to convert carbohydrate, *e.g.,* starch, which they claim to be a natural foodstuff, into sugar. It is certain that if sugar were tasteless or not sweet, it would not be so popular as it is, and thus it must rank as a condiment as well as a food. It is interesting to recall that sugar was scarcely a commercial commodity a little over a century ago, and that before that our ancestors got on very well without it, while, as a matter of fact, a big section of the community consumes nowadays very little or none of it. The history of starch in the dietary, on the other hand, goes back to the very beginning of things, and there was a supply of starches long before sugar was thought of in its present form.

Custom and cheapness have brought sugar into wide use, but in time of war its employment in many extraneous and totally unnecessary ways should be prohibited. After all, diet is largely ruled by custom, and war has gone to show that many customary articles of food which were considered essential by the public cannot only be dispensed with, but be dispensed with to the benefit of the general health.

Alcohol in War Economics.—The war in Europe has had a great effect on the consumption of alcohol. It need hardly be pointed out that in the economics of war the question of alcohol stands out most prominently. The value of alcohol as a food or even as a fuel may be dismissed as trivial in comparison with the harm that it does, and the waste of men and food and feeding material in its manufacture.

The food or fuel value of alcohol is so slight as to be a negligible quantity. It has been established that about one ounce of absolute alcohol is the limit which can be burned up in the body within a period of twenty-four hours without paralyzing or narcotic effect, and without the appearance of unchanged alcohol in the excreta, and one ounce of alcohol supplies about as much fuel as one ounce of margarin, 200 calories. Now one ounce of alcohol costs in the form of cheap spirit not more than four cents; in the form of beer less; in the form of heavy wines, 8 to 12 cents; in the form of light wine, 24 cents; while to these prices must be added some 40 or 50 per cent during war time. One ounce of margarin costs about 2 cents. Therefore, even if alcohol is regarded as a food, it is an extremely wasteful and expensive one.

Perhaps the sudden withdrawal of alcohol in any form from those with whom its use has been habitual may be followed by injurious effects on muscular and nervous energy. It is conceivable that men who for years have been accustomed to taking some form of alcoholic beverage as a part of their diet after a hard day's labor, might be affected by its sudden and complete withdrawal. Possibly in any regulations drawn up for the restriction or prohibition of the manufacture or sale of alcohol, it might be deemed wise to make allowance for the cases of those in whom total abstinence produces ill effects. There are other difficulties in the way of enforcing prohibition, such as the probable development of an illicit traffic in alcohol and the introduction of substitutes for alcohol which might be infinitely more detrimental to public health and order.

When all is said that can be said in favor of alcohol and of the disadvantages of its total withdrawal, these will weigh almost as nothing against the obvious manifest advantages of prohibition as a war-time measure. When food is scarce and the food situation serious, the question of the control of the liquor traffic becomes insistent from the point of view of national efficiency. To this argument may be added the further contention that the loss of energy value involved in the conversion of the carbohydrate of grain and sugar into alcohol represents in itself a serious leakage in food supplies. It must be remembered that there is an inevitable loss of energy in the conversion of these more highly organized bodies into the simpler alcohol; only some 60 per cent of the energy in the barley grain or the potato flour remains in the resulting beer or spirit. In itself brewing or distilling is a gross waste of food products.

By the enforcement of total abstinence at a stroke, the consumption of the thousands of tons of grain employed in the manufacture of beer and spirits would be saved, a vast amount of energy now employed in

brewery, distillery and saloons would be diverted into more profitable channels, and the health and morals of the nation would be raised. By the cessation of the manufacture of alcohol, and the utilization of its raw materials, especially of potatoes and grain, as immediate sources of food supply, the strain of providing the population with nutriment will be, to that extent, relieved.

For industrial and scientific purposes, alcohol is valuable, and to supply the needs in this direction, the manufacture, perhaps, of a limited amount should be permitted. But so far as beverage is concerned, the war has taught the lesson that human efficiency can be maintained at a higher standard without alcohol than with it.

The Food Situation in the United States.—More food is produced in this country than in any one country of the world, and yet at the present time there is a food shortage. This shortage is due to many causes: (*a*) Food production has not kept pace with the growth of population and has been giving alarm to agricultural experts for several years. During the past three decades Americans have been forsaking the farms for city life, and as a consequence agricultural labor has been becoming more and more difficult to obtain. Thus the food problem has been greatly hampered by the lack of agricultural workers, and this has been especially noticeable since the outbreak of the great European War. (*b*) The opportunity for securing employment in manufacturing establishments, the consequent high rate of wages and the inducements of city life have enticed many agricultural workers to forsake the farm, which has seriously interfered with the necessary labor for agricultural work and has added much to the serious phases of agricultural pursuits.

Since 1884 the production of wheat in this country has dropped a very considerable extent, due to the inability of the farmer to procure the necessary help. Farmers are now killing their live stock and as a conse-

CEREAL PRODUCTION OF THE UNITED STATES IN 1915

Cereal	Acreage	Bushels
Corn	108,321,000	3,054,535,000
Wheat	59,898,000	1,011,505,000
Oats	40,780,000	1,540,362,000
Barley	7,565,000	237,009,000
Rye	2,856,000	49,190,000
Buckwheat	806,000	15,769,000
Rice	694,000	65,691,700

quence supplies of meat in cold storage have fallen off enormously. The high prices of all kinds of foodstuff since the beginning of the European War, have resulted in a very marked increase in the export of all foodstuff, which unfortunately does not signify an increased ability to produce food, but on the other hand means rather that we are depleting our existing stock of supplies.

In 1916, harvest conditions in the United States were much below normal production and, in short, it has been plainly demonstrated that our reserves in cereal grains are being rapidly exhausted. It has been computed that our Allies' cereal crop this year has shrunk to about 525,000,000 bushels below normal, and if consumption in the allied countries is to be maintained at or near normal no less than 1,250,000 bushels of grain must be exported by the United States. The cattle and hogs in the allied countries are diminished in number by something like 30,000,000 head, and these reductions will continue with increasing severity for the reason that animals must be slaughtered on account of shortage in food supplies. We have not only to feed the people of our own country, but we are also expected to make up the food deficiency of our Allies, and thus the burden of the war, so far as supplying subsistence to the Allied armies is concerned, falls most heavily on the United States.

If this war is to be won by our Allies, food must be strictly conserved by the American people. We shall consider briefly the food problem from an economic viewpoint. It may be safely said that our own people, up to the present time, seem to have failed to realize adequately the all-important rôle that food will play in this war and there is grave danger in the fact that the necessity for economy in diet is not sufficiently appreciated. It has been pointed out in a previous section of this chapter, that under the compelling stress of circumstances, the nations at war in Europe have restricted and regulated the consumption of food, and avoided waste in every possible way, and, moreover, that up to a certain point, this has been done with correspondingly decided benefit to the public health. As a matter of fact, economy in diet in this country, if arranged on sensible and scientific principles, should be attended with little or no injurious effects on the health of the population. Such economy may be uncomfortable for a time, but man is extraordinarily adaptable, and in a short time, provided he gets a sufficient quantity of fat and energy-producing foods in well-balanced proportions to keep the human machine working, it does not matter much whether his subsistence is derived mainly from the vegetable or animal kingdom. As previously

pointed out in this work Americans are large meat eaters but so were the Germans and British before the war.

The Germans and, to a lesser extent, the British, have denied themselves meat with a good deal of philosophy and with benefit rather than harmful results. Educational propaganda with regard to food economy in this country should not only dwell on the need for economy and self-denial, but should lay special stress upon the point that comparative deprivation of meat and the substitution of nutritious articles of food for those to which the population has by long use become accustomed, invokes no special hardships, while in many instances a restricted diet may be beneficial.

In the first place the foodstuffs exported by us must be of a most concentrated kind, as for example, wheat, beef, pork, dairy products, fats and sugar. Although we have a surplus of potatoes, vegetables, fish and poultry, these, with the exception of vegetables in *dehydrated* form, do not lend themselves to shipment.

As said before, the wheat supply is short and the food administrator has requested the population of this country to eat corn bread and conserve the wheat for our Allies. Corn meal, when properly prepared, can be made as nutritious, as wholesome, and as palatable as wheat bread. We are the largest corn growing nation in the world and our people, unlike the Frenchmen and Englishmen, are not averse to eating corn bread. Accordingly the first logical step in adapting our food supplies and consumption to the needs of our Allies is to substitute, as far as possible, corn for wheat on our own tables. Furthermore, when wheat bread is placed upon the table it should be baked from whole wheat meal. The bread on which our sturdy grandsires throve was made from the whole wheat berry and the ingenuity of man has never devised a more wholesome, more palatable nor more nutritious bread than that made from the whole wheat grain. This point has been previously dwelt upon in other portions of this work. The reasons why whole wheat flour should be used are as follows: When properly made and baked, bread made from whole wheat flour is more nutritive and digestible than bread made from highly milled and finely bolted white flour; besides it contains all of the cereal salts (1.75 per cent), while highly bolted white flour is deficient in cereal salts (only .44 per cent). Moreover, the modern patent roller process flour is deficient in vitamines, while the whole wheat flour contains all of the vitamines which nature grew into the wheat berry.

Graham Lusk, who has devoted much research to the subject of scientific nutrition, advocates the consumption of graham (whole wheat) bread,

and several authorities on nutrition, both in this country and in Europe, are enthusiastic over the nutritive properties of whole wheat bread. In fact, just a few months ago an edict went forth in Great Britain that all flour should be ground from the whole wheat grain. A feature in favor of whole wheat meal is that bread made from it requires more mastication and exerts a considerably more laxative effect than bread made from highly bolted patent roller process flour which predisposes to constipation and intestinal stasis, complaints which are widely prevalent in this country. However, the advantages of whole wheat bread have been sufficiently emphasized.

The question of protein consumption has given rise to considerable discussion, or, perhaps, it is more correct to say that the discussion has hinged on the point as to which form of protein should be taken as food. There is virtually no difference of opinion with regard to the need of protein. To a greater or lesser extent, it is known, that on the whole, more protein in the form of meat is eaten than is physiologically required. It certainly is a fact that owing to the false teaching and long held beliefs of the strengthening effects of meat, too much meat is consumed by both young and old with harmful results to both. This subject has been previously considered and we will not enter into a dissertation here regarding protein as a food; it will suffice to say that the protein of meat can be replaced by vegetable protein, such as that from the legumes, whole wheat flour, and various vegetables. These are cheaper by far, more easily and economically produced, and will maintain the body at a high standard of efficiency and health; therefore, the next step in the direction of food economy is to substitute, as far as possible, protein from the vegetable kingdom. Moreover, fish can be largely used as a substitute for meat and we have fish in great abundance.

Unfortunately the fat content of a well-balanced ration is not transmutable. No substitute can be offered in the place of fats, but some very useful advice can be tendered. A large reduction in the ordinary consumption of fat by the well-to-do citizen will be helpful to the nation and to the individual. Graham Lusk, writing in the *Scientific Monthly,* October, 1917, draws attention to the fact that it is not at all difficult to reduce the body weight by reducing the consumption of fats and starches and cutting down the energy value of their ration from 2,800 calories to about 2,200 calories. The fuel foods for the human machine are principally made from wheat, corn, rice and the sugar cane.

The average American consumes more sugar than is necessary or beneficial and if we are to be able to export any sugar to our Allies the

per capita consumption must be reduced in this country. This is one aspect of the food situation in this country which has not been met as it should have been met.

The author, at the outbreak of the war, suggested that the use of grains for the manufacture of intoxicating beverages should be stopped. The grain that is now being used for the manufacture of intoxicating drinks, if employed for human consumption or for fodder for animals, would relieve the present stress to an unbelievable degree. The employees thrown out of work by prohibition would soon find other spheres of human endeavor in which they would be much more useful to the community. The greatest source, perhaps, for the inflation of the prices of foodstuffs is the present manipulation of the food markets by speculation. And another point in the present high cost of living and bad food preparation is a want of knowledge in the culinary department. For a couple of decades past the science of cookery has not been taught in the home as it should be, and as a result the daughters, with the exception of a few who have been trained in domestic science schools, are unacquainted with the uses of the culinary utensils of the modern household.

Lusk, referred to previously, formulates the following propositions, which are so apropos to the subject that no excuse for quoting them is necessary: "(*a*) Eat corn bread and save the wheat for France and our other Allies; (*b*) Let no family of five persons buy meat until it has bought three quarts of milk; (*c*) Save the cream and butter and eat vegetable oils and oleomargarin; (*d*) Eat meat sparingly, rich and poor, laborer and indolent alike; (*e*) Be a prohibitionist for the period of the war; (*f*) Save everything that can be used for food, because food is precious; (*g*) Finally, remember that the whole world is seeking for food with which to work and although our wheat crop is short, still we are the nation most richly endowed with fuel food. It remains to be seen whether we have the intelligence to fitly utilize for the welfare of mankind the resources which God and nature have placed in our hands."

The only solution of the food problem is to eat more of the foods which can be easily raised and less of those which are so urgently needed by our Allies. As our food dictator has stated, "There is no real conservation without reduction in consumption, and the elimination of personal waste."

If the people of this country will heartily coöperate with the food conservator in the endeavor to conserve the food supply, and will endure for a while some discomfort, there will be no difficulty regarding the food problem. Sufficient food can be produced to keep the population supplied with a well-balanced dietary with sufficient to export for the Allies. The

case of Germany has plainly demonstrated this fact, but in this country the populace must be educated with respect to scientific nutrition and must come to realize that personal selfishness must be subordinated to the national interest.

SUMMARY

As remarked in the introductory sentences of this chapter, the author is of the opinion that in a work on diet, notice should be taken of the food question in war, and that an attempt should be made to extract whatever lessons in this direction might seem apposite.

The conclusions to be drawn as the result of this survey—for it can hardly be termed a close study—are: That the limitation of food consequent upon a short supply brought about by war conditions is beneficial to a certain proportion of the population, further demonstrating the fact that in the ordinary way the majority of persons eat more than their physiological requirements call for. On the other hand, a restricted food supply presses heavily on those least able to bear the pressure, that is, on those who, on account of the greatly enhanced price of food, are unable to obtain the kind of diet to which they are accustomed and indeed suffer from a paucity of nutritive elements. It seems to have been proven that overfeeding is injurious, but that underfeeding is worse.

So far as the different essential constituents of the food are concerned, at the time of writing it is impossible to speak dogmatically. It appears to have been demonstrated that more protein is generally eaten than is needed, and not enough fat. The Germans, according to Taylor, suffered from the limitation of fat in their diet, and it may be stated that fat is a more important factor in the promotion of physical efficiency than hitherto has been believed. One of the chief lessons learned from the war so far has been the great economical and nutritive value of whole-grain bread. The proven dietetic value of whole-grain bread, and of cereals from which the husks have not been removed, suggests the reflection that possibly the value of food, after all, depends no more on its protein, fat or carbohydrate content, as the case may be, than on the possession of those food elements termed vitamines. Certain it is that when these are absent, ill health and disease are generally the sequence.

In this chapter some opinions have been expressed with regard to milk which do not seem to be in accord with the views of authorities. The opinions propounded here, while not entirely those of the author, still are his to this extent, that he does believe that milk *per se* is not an indispensable article of diet except for infants, and that the best use that can be made

of milk, in war time at any rate, is its conversion into cheese, one of the most wholesome and nutritive foods known. A good hunch of crusty bread, with butter and cheese or fat bacon, followed by a little raw fruit, such as an apple, constitutes a well-balanced meal.

It has been pointed out that the question of sugar is a vexed one. In England it appears to have been concluded that its dietetic virtues have been exaggerated, and that in war time its consumption, with great benefit to all concerned, might be very considerably restricted. With regard to the liquor traffic in war time, there is and should be very little difference of opinion. The grain, potatoes, etc., that are employed in the manufacture of alcohol in war time should be utilized for feeding men and animals and in every respect the manufacture of alcohol to be used as a beverage should be restricted to a minimum or wholly interdicted.

Finally, there are at least four ways of reducing the consumption of food: 1. By preparing the food in the most economical way. 2. By minimizing waste. 3. By selecting the right kinds of food and in the right proportions. 4. By limiting to a sufficiency the quantity of food consumed.

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